POWER

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Moderation

HAVE you ever stopped to consider the importance of the idea conveyed by the word "Moderation"? That one word would make a good sign to hang up beside the "Safety First" card, where everyone would see it.

There are two men likely to be found around any power plant who have to be watched. One is the man who thinks that things "that are" must be the best because they "are." The other thinks that anything new must be best because it is new. The man who picks his way between these two is the one who gets results.

The "Let's-try-something-new" man thinks he stands for progress, and often he does, but unless he is very careful his progress may lead to chaos. The only kind of progress that pays is progress in the right direction.

The "Old Fogy" thinks he stands for what is sure to be right because it has seemed to be right in the past. If his advice was followed entirely, no progress would ever be made. In fact, we wouldn't have any power plants to make progress in.

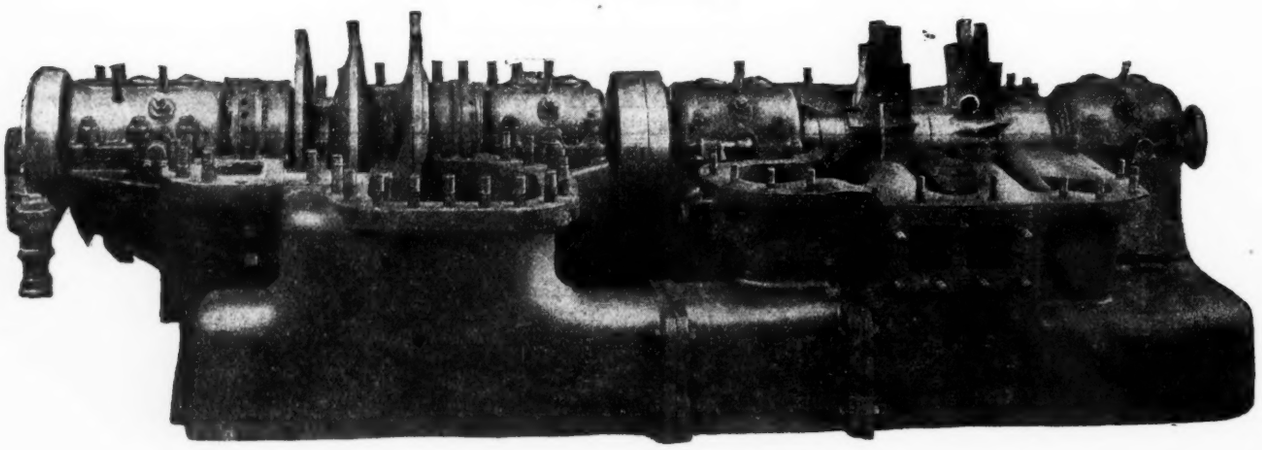
The man whose motto is "Moderation" listens to both stories. He knows that only by using the new things and the new ideas can improvements be made. He also knows that a modern plant cannot live if it stands still. It must go ahead. On the other hand, he realizes that a new idea is not bound to be good just because it is new. If an idea has been used, and proved its worth, it should not be discarded simply to make a change. As the lawyers say, "The burden of proof is on the advocate of a change."

Enthusiasm is a great thing, but enthusiasm tempered by moderation is much greater.

Contributed by Waldo Weaver

High-Speed Turbine-Driven Blowers

By C. H. SMOOT*



DEVELOPMENT of the centrifugal blower into its modern form permits high speeds of rotation and economical machines handling small volumes to high pressures. When the speed of rotation is limited, a given pressure generally determines a given minimum horsepower volume which can be handled economically by a turbo-blower. By using high rotative

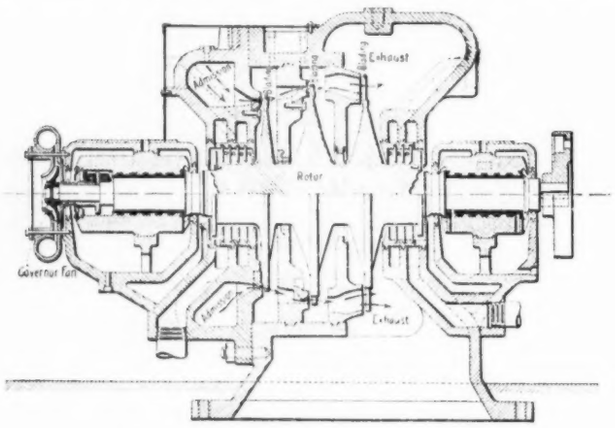


FIG. 1. SECTION THROUGH TURBINE

speeds, this limit can be removed, and turbo-blowers built in a range of capacities and pressures otherwise impossible.

On raising the speed of rotation for a given horsepower output, the first limit encountered is at the turbine. It is more difficult to find means of constructing a high-speed turbine than to find means of constructing the turbo-blower which the former will drive, and in almost every instance the limit of rotative speed is found in the turbine end of the unit and not in the blower. The type of high-speed turbine and blower which the Rateau Battu Smoot Co., of New York City, has developed is shown in the headpiece and also in Figs. 1 and 5.

The most significant feature in the turbine construction is the use of a single steel forging for the entire rotating element, as indicated in Fig. 1. The shaft and disk wheels are made integral, with turbine buckets mounted in the periphery of the wheels; the latter are virtually collars on the shaft. As a result the shaft diameter can be made as large as desired to accomplish the almost necessary condition of having its critical speed above the speed of rotation. Since the disk wheel is integral with the shaft and is not a perforated ring of metal, its stresses can be maintained low, as the shaft where it passes through the wheel contributes its full share in holding the wheel against centrifugal strains. A wheel that is made separate from the shaft,

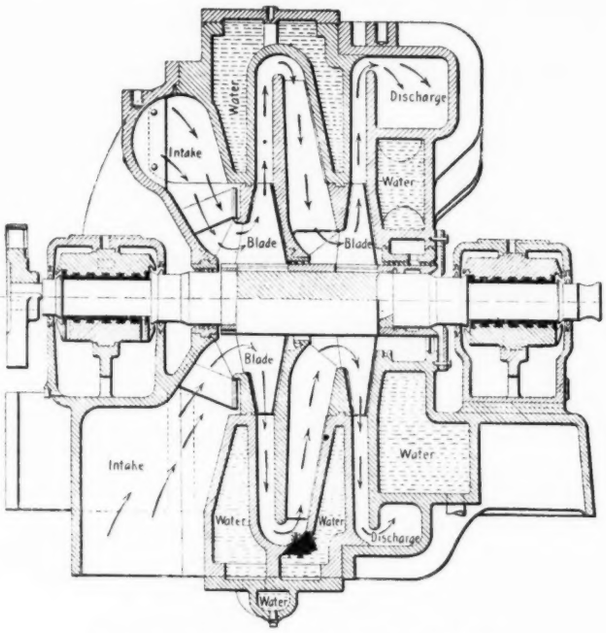


FIG. 2. SECTION THROUGH BLOWER

on the contrary, requires either material that will stand much higher stresses, or, on the other hand, the shaft must be made so small that the machine passes through its critical speed, both conditions being objectionable and both conditions being eliminated by the use of the integral construction.

The turbine shown to the left in the headpiece and in Fig. 1 is a three-stage high-pressure condensing machine in which the bucket velocity is sufficiently high to use economically the available heat energy between boiler pressure and vacuum. The design of the rotor

*Engineer, Rateau Battu Smoot Co.

permits this high bucket velocity and maintains the working stress well within safe limits. The blower driven by this machine is direct-connected, and its rotor construction is in principle similar to that of the turbine. The blower blades which constitute the impeller are similar to those in Fig. 3 and are mounted with a dove-tailed construction direct in the blower shaft, Fig. 4, no disk wheel being used. In consequence the blower shaft can be of ample diameter and stiffness to obviate its passing through the critical velocity. Since the centrifugal effort of the impeller blades is held by the metal of the shaft, this metal serves the double purpose of giving proper stiffness to the shaft and at the same time holding together the impeller against centrifugal effort.

FIG. 3. BLOWER BLADES

The blades are made with a large cross-section at their root, and taper to a small cross-section at the periphery in such a way that the stress is practically constant throughout the blade section. The diffusion action of the blower is accomplished in an annular passage surrounding the impeller wheels, in which no stationary guide blades are employed, following the practice in many water pumps, and through the proportioning of this diffuser extremely efficient velocity conversion into pressure is obtained. Also, the absence of the guide blades entirely eliminates the siren action, which has frequently made turbo-blowers objectionably noisy. The section through the blower, Fig. 2, clearly indicates by arrows the path of the air.

The stationary part of the turbo-blower is entirely water-jacketed by the use of large water spaces, also indicated in Fig. 2, which may be readily inspected and cleaned of sediment. The passages contain a relatively large amount of water, which keeps the temperature of the blower casing sufficiently low to avoid distortions and misalignment of the machine when running for long periods on a closed discharge.

The machine shown in the headpiece, with the upper half of the casing removed, and in Figs. 1 and 2, is capable of developing 1,000 shaft horsepower maximum, and compressing 15,000 cu.ft. of free air to 15 lb. pressure when running at a speed of 8,750 r.p.m. This pressure is obtained in two stages, of two sets of impeller wheels in series. Similar machines are being constructed in which a pressure of 15 lb. is generated in a single impeller wheel, and in these units the working stress is likewise maintained well within the safe value. The 1,000-hp. units have been tested up to a speed of 10,000 r.p.m. and operate in a most satisfactory manner at this speed. The compactness of these units is evidenced by their dimensions, being only 12 ft. 6 in. over-all length and 4 ft. 6 in. outside diameter for the blower, and 3 ft. 4 in. diameter for the turbine. In the design and operation of units under these conditions, many interesting features have been developed. The bearings, for intance, are of much more importance to the units as oil dashpots than for the purpose of bearings, and a surprising amount of "out-of-balance" can be absorbed in the bearings themselves. A simple cast-iron babbitt-lined bushing of imple size is employed for this purpose.

In order to control the speed of units of this and greater rotative speeds, a new form of governor has been developed in which the speed element is a small steel fan mounted rigidly on an extension of the turbine shaft. The pressure of the fan varies as the square of the speed of rotation in a manner analogous to that of a fly-ball, and this pressure is used in a static regulator of very simple form which controls the admission of steam. The governing is accomplished through pressure regulation on the small direct-connected fan. Very satisfactory speed regulation is obtained in this manner through exceedingly simple apparatus, which has a very small probability of derangement.

One result from the development of this type of turbine, which may be of significant value in the future, is that it has been shown that a noncondensing turbine of high efficiency can be constructed along these lines of design. Since at the high speed of rotation a large amount of the power may be generated in wheels of small diameter, the proportion of lost energy due to windage in the small high-speed machines is less than in the corresponding slower-speed machine.

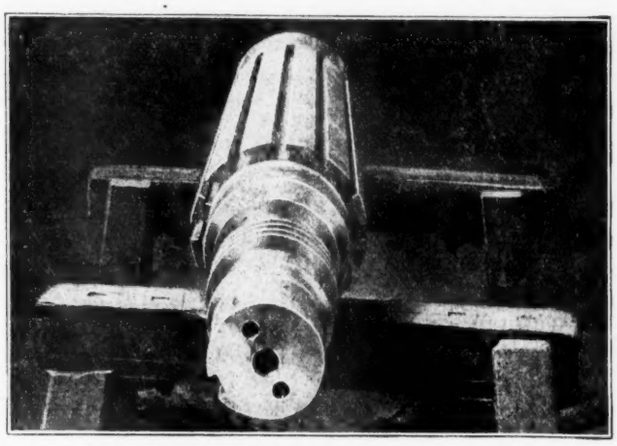


FIG. 4. BLOWER'S ROTARY SHAFT, SHOWING DOVETAIL GROOVER FOR ATTACHING BLADES

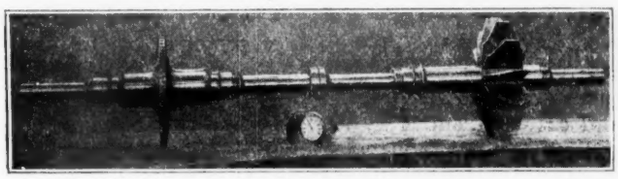


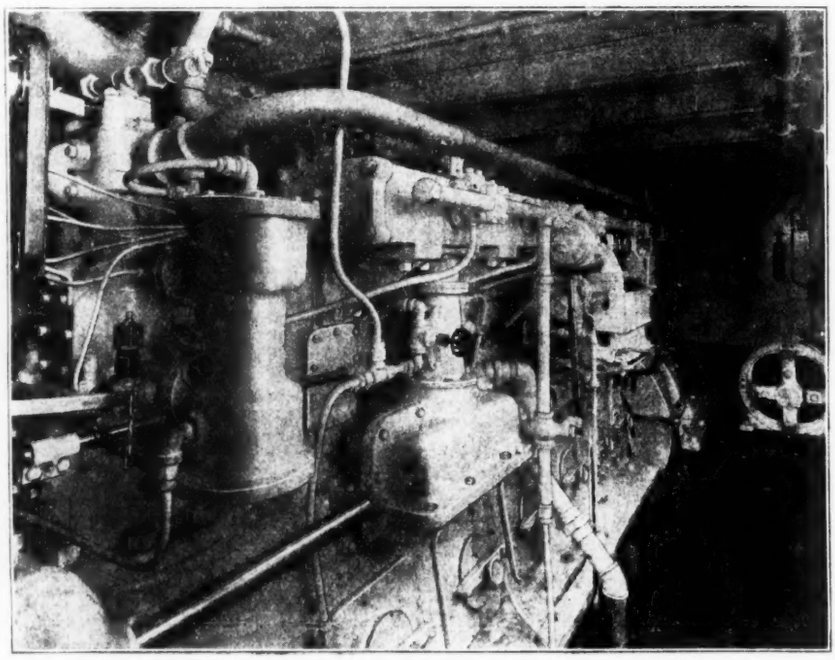
FIG. 5. TURBINE AND BLOWER ROTOR FOR 150-HP. 20,000 R.P.M. MACHINE

These machines have been built in sizes of 150 hp., operating at 20,000 r.p.m., to 2,300-hp., operating at 1,500 r.p.m. The rotor of the 150-hp., 20,000-r.p.m. machine is shown in Fig. 5. The combined weight of the turbine and blower rotor is only about fifty pounds. In this type of machine the blower and turbine rotor are each made from one solid steel forging. A 150-hp. turbine and blower of the foregoing type that operated at 60,000 r.p.m. was built in France during the war for use on an airplane. This machine weighed only about thirty pounds.

Diesel-Electric Equipment of the Yacht "Elfay"

A PRACTICAL application of oil-electric drive in which some form of oil engine drives an electric generator which in turn furnishes power to motors driving the propellers is to be found in the yacht "Elfay," a schooner 152 ft. over-all, 30-ft. beam, and 313 gross tons, which went into commission in January, 1920. Among the chief advantages claimed for this drive are the following:

The engine operates continuously at constant speed in one direction only and therefore under ideal conditions; its fuel economy is exceedingly high; the electric system of distributing and applying power is flexible; a simple and effective form of control can be used; and greater safety can be secured through the use of several main engines and generators, as well as two or more main motors and propellers, so that part of the equipment can be out of commission without crippling the ship.



VIEW OF MAIN ENGINE, GENERATOR AND EXCITER

The "Elfay's" main engine is a six-cylinder, Model 54, Winton full-Diesel oil engine, with a 7½-in. bore, 11-in. stroke, and rated 115 hp. running 425 r.p.m. It is equipped with a sensitive governor, which controls the fuel supply and holds the speed of the engine practically constant, the maximum variation being about 20 r.p.m. A 75-kw. Westinghouse 125-volt direct-current generator is directly connected to this engine; and driven from it by a silent chain is a 9-kw. 125-volt exciter of 900 r.p.m. which supplies the field current for both the main generator and the propeller motor and has also about 5 kw. additional capacity for other purposes. The propeller is driven by a 90-hp. Westinghouse motor of 350 r.p.m. At the maximum motor speed the speed of the boat is 8½ knots. It is claimed that this boat can make 8½ knots on 7½ gal. of fuel per hour. Since this boat carries 2,400 gal. of fuel, she is able to run 2,000 miles on her propelling equipment alone. All the electrical machines—the generator, exciter and motor—are of standard design, the only special element being the use of ball bearings to permit operation with the vessel listing on a wide angle.

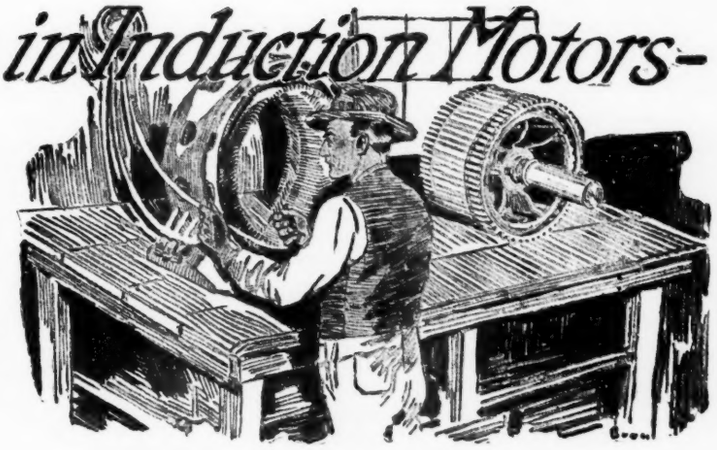
The method of controlling the ship is an interesting feature of the installation. When it is desired to use the power, the engineer starts the engine with its generator and exciter and brings them up to speed. He then closes the switches that connect the propeller-motor armature with the generator and the propeller-motor field with the exciter. After this he has no further responsibility in the handling of the ship, except to keep the machinery running properly. The entire control of the propeller is centered in a handle that is mounted on a pedestal on the deck just forward of the steering gear. In the center position of this handle the propeller motor is stopped. By turning the handle in one direction, the motor starts driving the ship ahead with continuously increasing speed as the handle is turned, until full speed is reached. By turning the handle in the other direction the ship is driven astern in a similar manner. The change from full speed ahead to full speed astern can be made in five seconds. In front of the control handle a set of meters is mounted, which show the voltages of the generator and the exciter, the current taken by the motor and the speeds of the generator and the motor. The navigator, therefore, has complete control of the vessel and can maneuver with the utmost speed and precision. The fields of both the motor and the generator are separately excited, as has already been stated in the foregoing. The motor field is kept always at full strength when the motor is in service, but the strength of the generator field is varied by means of a rheostat which is operated by the control handle. In the off position of this handle the generator field is open so that no current is delivered to the motor. As the handle is moved around, the generator field strength is increased and the voltage of the current supplied to the motor, consequently the motor speed, is also increased. When the control handle is reversed, the direction of the generator field current, and also the current to the motor and its direction of rotation is reversed, but otherwise the action is the same.

The "Elfay" is lighted and heated by electricity and all her machinery is electrically operated. There is also a ½-kw. wireless outfit. All this apparatus is supplied with power from the exciter when the main engine is operating and from a storage battery when the main engine is shut down. This outfit consists of a 300-ampere-hour Philadelphia battery, which is charged by means of an auxiliary generating set consisting of a 25-hp. Quayle engine, with an electric starter, which drives a 15-kw. generator. The battery has capacity enough to supply the needs of the boat (with the exception of propulsion) for two days without recharging.

Locating Faults in Induction Motors—

How to Make Tests

By
A. M. Dudley*



Tells How To Make the Tests Necessary To Locate Ten Most Common Faults That May Occur in Induction-Motor Windings.

AFTER the enumeration of the commonest errors made by the winder, as outlined in the article "Locating Faults in Induction Motors—Most Common Defects" in Mar. 2 issue, the next step is to consider them in turn with particular reference to how each may be detected and corrected.

First Fault: Grounds. If the ground is fairly low resistance—that is, the bare copper of the winding touches the core—the defect may be detected by using an incandescent lamp arranged as shown in Fig. 1. One of the lamp leads is touched to a bare spot on the winding—for example, a terminal connector or a "stub" where two adjacent coils are connected—and the other is touched to the bare metal of the motor frame at some point not protected by paint. If there is a ground present, the lamp lights up. Another common method is by "ringing out" with a magneto similar to that used in telephone work. In this method the terminals of the magneto are applied, one to the winding and the other to the frame similar to the procedure in Fig. 1, and the handle is turned. If the bell rings, there is probably a ground in the winding. A third method employs a "testing box," which is really a transformer for obtaining voltage much higher than the normal voltage of

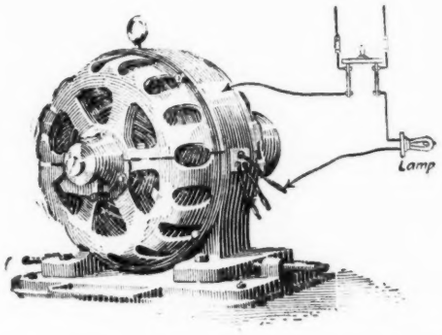


FIG. 1. CONNECTIONS FOR TESTING MOTOR FOR GROUNDS WITH LAMP

the motor under test. These boxes give 2,000 or 3,000 or more volts and readily detect grounds on windings of 550 volts and below. The test box is so arranged that when the terminals are applied as in Fig. 1, the presence of a ground instantly opens a circuit-breaker on the side of the box.

Having established the fact that the winding is grounded by some one of the foregoing methods, the next problem is to locate in which coil or what part of the winding it has occurred. This can sometimes be done by inspection, but sometimes requires other means. The most usual of these is to put enough voltage on the ground with the lamp device of Fig. 1, or the test box, so that the resulting current heats up the contact that is causing the ground and it becomes evident through smoke or slight arcing. This will generally require two or more lamps connected in parallel. When the ground is definitely located, it is corrected by repairing the insulation at this point by retaping the coil, or replacing the defective slot cell or whatever may be causing the trouble. Sometimes the ground cannot be "smoked out" in this manner, and it then becomes necessary to open up the winding at two or three places and test out the different pieces to find in which one the ground is present. If it is still not evident, the defective section of the winding is further broken into smaller pieces and the search pursued until the trouble is finally run down to the individual coil which is defective. It is seldom necessary to go so far, as the ground furnishes evidence of its location as soon as the voltage is put across it.

Second and Third Faults: Short-circuit of a few turns in a coil, or a single coil completely short-circuited, becomes hot in a short time if the motor is run light on normal voltage. Their presence can be detected by feeling around the winding with the hand immediately after starting the machine and noting if some individual coils are much warmer than others. A device for detecting such short-circuits before the rotor is put in the stator and without applying any voltage to the winding itself is shown in Fig. 2. This device is somewhat similar to a large horseshoe magnet excepting that the iron part is built up of laminations, or it may be considered as a core-type transformer having a primary coil only with one side of the iron core missing. The coil is excited with alternating current of suitable voltage, and then the complete device is passed slowly around the bore of the machine being tested as shown in Fig. 3. In passing around, if the testing device passes over any short-circuited turn or coil, such short-circuit immediately acts as a short-circuited secondary coil on a transformer of which the exciting coil on the testing device is the primary and whose magnetic circuit is made partly by the testing device and partly by the core of the machine under test. As in any short-circuited transformer, an increased current flows both in the primary and secondary coil and can be detected by an ammeter in series with the device or by the heating that immediately takes place in the defective coil, or by the attraction that the short-circuited coil has for a strip of sheet iron. By passing the device slowly around

*Designing engineer, Westinghouse Electric and Manufacturing Co.

the core and observing its behavior from point to point, short-circuits can readily be detected. This refers particularly to short-circuits in individual turns or in one complete coil. A short-circuit of a complete pole-phase group is more readily located by a compass test, and a short-circuit of an entire phase can be located by a "balance test."

The "compass test" referred to in the preceding paragraph consists in passing a compass slowly around

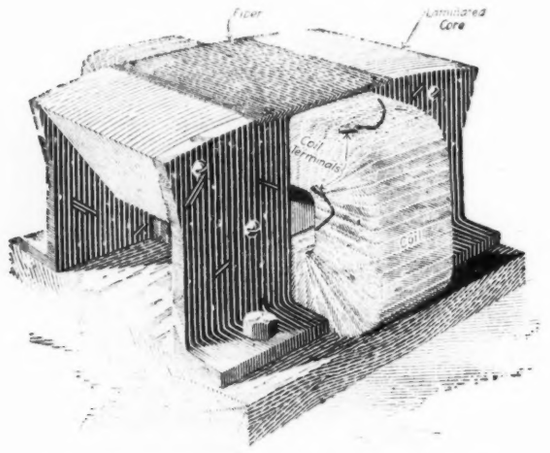


FIG. 2. TESTING DEVICE FOR LOCATING SHORT-CIRCUITS IN STATOR WINDING

the bore of the stator from which the rotor has been removed and which has the winding excited by direct current of the value of about one-third the full-load alternating current. The effect of this direct current is to set up north and south poles alternately in the phase which is excited, and as the compass is passed slowly around the bore its needle reverses with the polarity, and by marking the polarity plus and minus with chalk marks in the bore, the chalk marks immediately indicate the correctness or faults in the winding. If it is a two-phase machine, the direct current is put on each phase separately and the check is made. For a three-phase star winding cause the direct current to flow from each lead to the star by making three observations and mark the polarity only on the groups from the lead to the star in each phase separately. This can be readily understood by referring to Fig. 4. For the first observation put the direct-current plus lead on *A* and the minus on the star connection, then pass the compass around the bore and mark the polarity of the groups from *A* to the star point with an arrow, the arrow pointing in the same direction as the compass needle. For the second observation put the direct-current plus lead on *B* and the minus lead on the star connection and passing the compass around marking the polarity of the groups from *B* to the star point. For the third observation put the direct-current plus lead on *C* and the minus on the star, and by means of the compass determine and mark the polarity of the groups from *C* to the star point. If the three observations have been made correctly, there will be a chalk arrow on each pole-phase group of the winding, and if the winding is correctly connected, these chalk arrows will alternate north and south, as shown in the Fig. 4. In case of a short-circuit of a complete pole-phase group the compass needle will not be deflected. If a three-phase delta winding is being checked, open the delta connection at one lead, as in Fig. 5, and connect the direct-current source in so that the current flows through the three phases in series, and if the pole-phase groups be checked for polarity, the arrows will reverse as just described for the star winding.

The "balance test" referred to consists in checking each phase of the winding separately with low-voltage alternating current, say 20 per cent of normal full voltage, and measuring the amperes to check the impedance roughly and see if it is the same in all phases. The connections for a star connected winding are made, as in Fig. 6, so that the current can be measured in each phase, with an ammeter. The low-voltage alternating-current source is, in all cases, connected across one terminal, *A*, *B* or *C*, and the star as in the figure. The ammeters should read the same in all three leads. For a delta-connected winding it is necessary to open the delta connections at some point, as at *A*, then test across each phase separately. This test is made on the stator only and with the rotor removed.

Fourth and Fifth Faults: Reversal of one or more coils in a group or group of coils. It happens that individual coils or sometimes entire groups are connected in backward. If the error is confined to one coil it does not usually show up on a "balance test" and would not be found on a resistance test, since the resistance would be the same no matter which way the coil was connected. Such reversed coils or groups can be located by means of the compass test described under "Short Circuits." If an individual coil is reversed, it will show a tendency to reverse the compass needle when the needle is directly over that coil. If an entire pole-phase group is reversed, the compass needle will indicate the same direction of field on three successive groups, as at *Z*, Fig. 7. Also if a coil is left out of circuit, or "dead," as listed under the

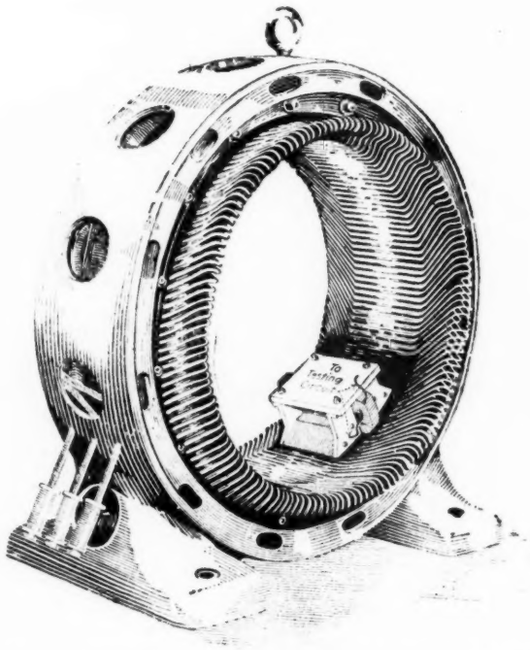


FIG. 3. METHOD OF USING TESTING DEVICE SHOWN IN FIG. 2

tenth fault, the compass needle will indicate an irregularity at the instant of passing over that particular coil. By checking the three phases of a three-phase winding separately, with a compass, as described under the second and third faults it is possible to check for the reversal of an entire phase.

Sixth Fault: This is the case where one coil too many or too few is connected in a pole-phase group, as at *A'* and *B'*, Fig. 7. The best check on this is a visual

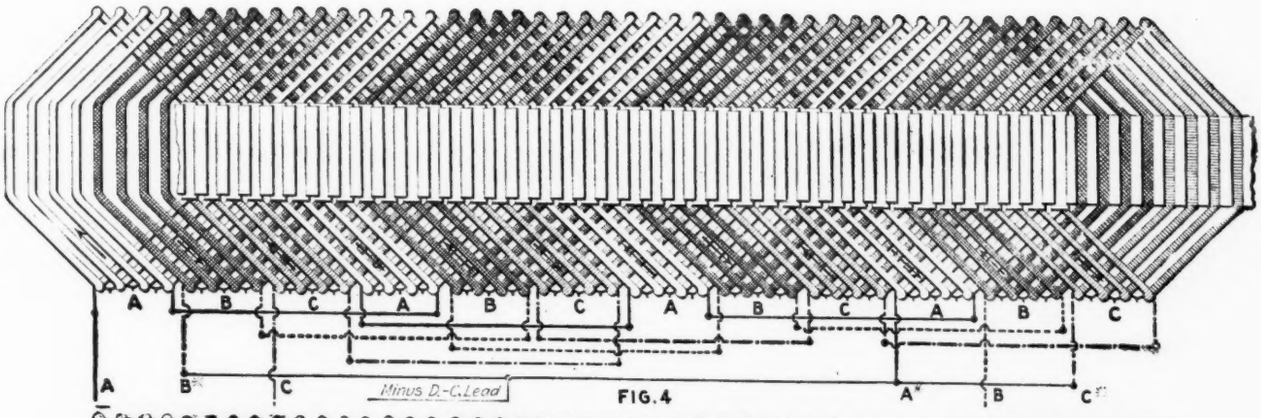


FIG. 4

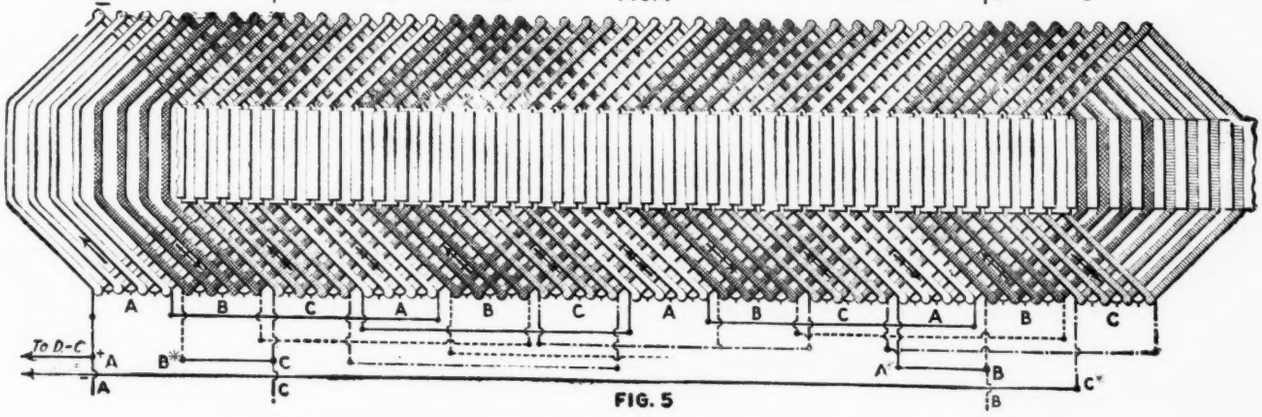


FIG. 5

FIGS. 4 AND 5. THREE-PHASE FOUR-POLE INDUCTION-MOTOR WINDING DIAGRAMS

Fig. 4—Three-Phase Four-Pole Series-Star Connection. Fig. 5—Three-Phase Four-Pole Series-Delta Connection, Showing Direct-Current Source Connected into Corner of Delta at A, for Making Polarity Test.

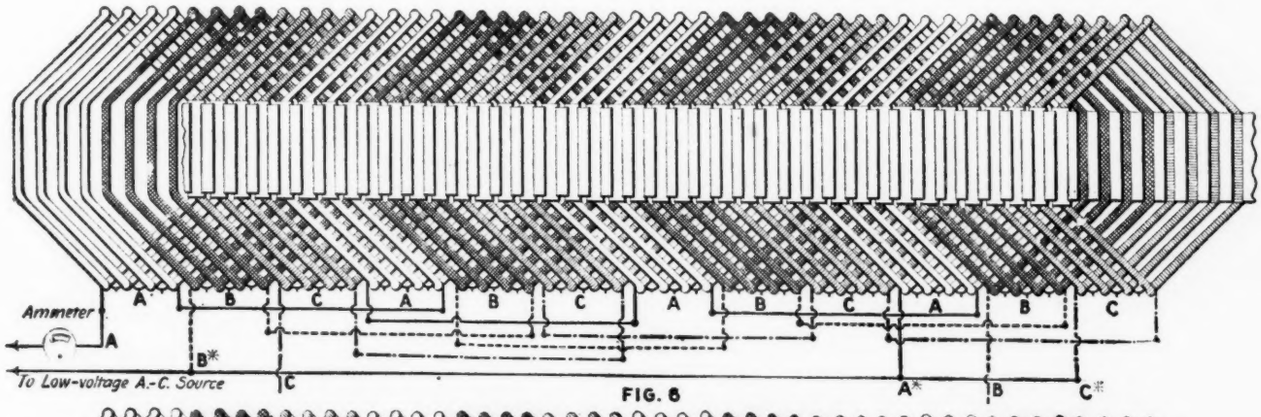


FIG. 6

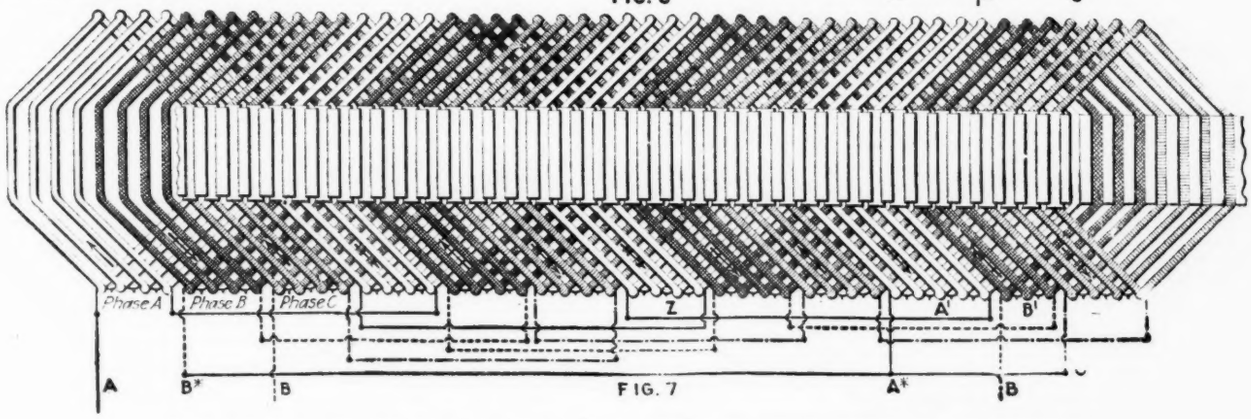


FIG. 7

FIGS. 6 AND 7. THREE-PHASE FOUR-POLE INDUCTION-MOTOR WINDING CONNECTIONS

Fig. 6—Method of Making Balance Test on Series-Star Winding. Fig. 7—Shows Wrong Connections in Series-Star Winding

inspection and count of the "stubs" at the end of each group, and when the trouble is located it is corrected by disconnecting, regrouping and reconnecting.

Seventh Fault: The reversal of an entire phase in a three-phase winding usually manifests itself in a very pronounced manner when the motor is run light. If the rotor turns over at all it is probably at a speed very much less than normal and emits a loud, growling noise and immediately becomes hot. This fault may also be detected by the compass test, as described under faults two and three. The arrows on the windings will point in groups of three in opposite directions, as in Fig. 8. The remedy when the defect is found is to open the star point and use the star point on the defective phase, which is the *B* phase in Fig. 8, for a lead and bringing the end that was a lead to the star, thus giving the connection, Fig. 4. In a two-phase winding there is no trouble with reversed phase for the reason that if the direction of rotation of the motor is wrong, the leads may be easily reversed outside of the motor and the correct rotation secured.

Eighth Fault: Connection for wrong voltage. If a motor is connected for a lower voltage than the circuit upon which it is operating, the no-load current becomes excessive and may even approach full-load value. There is a pronounced magnetic hum and a vibration indicating that the field is very strong, which is the case. On the other hand, if the motor is connected for a higher voltage than that upon which it is being tried, the no-load current is very small and the motor apparently "pulls

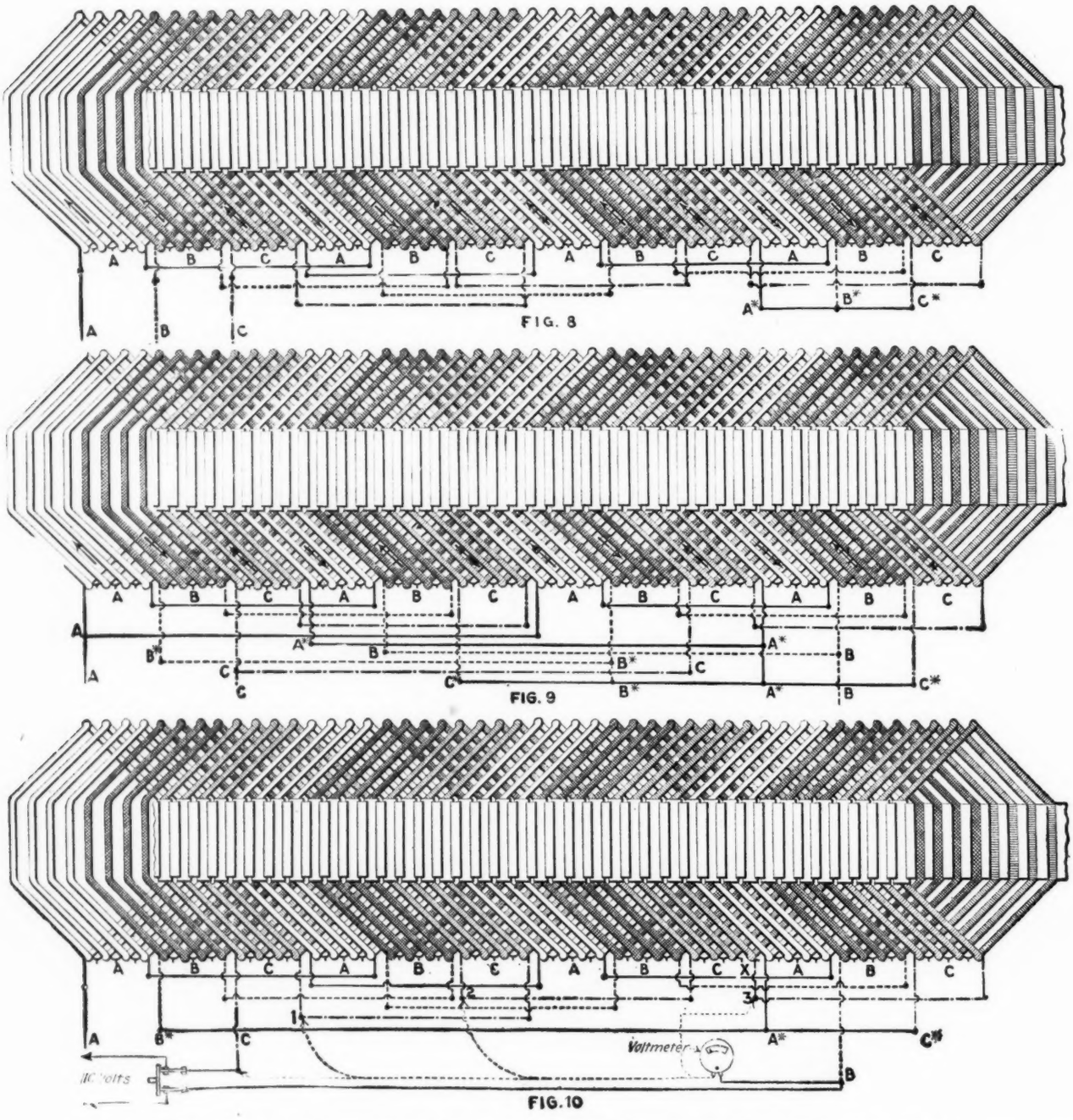


FIG. 8

FIG. 9

FIG. 10

FIGS. 8 TO 10. THREE-PHASE FOUR-POLE INDUCTION-MOTOR WINDING CONNECTIONS

Fig. 8—Series-Star Winding with B Phase Reversed. Fig. 9—Four-Pole Two-Parallel Star Connection. Fig. 10—Shows Method of Testing for Open-Circuits with a Voltmeter in a Series-Star Winding.

out" on much less than its rated full load. If these faults are a matter of half-voltage or double voltage, for example, they can usually be detected without much trouble; but if the variation is less, this becomes a more difficult matter and in the absence of any other official data it sometimes becomes necessary to take a brake test to determine what the trouble is. After the difficulty and its extent have been determined, a reconnection of the groups can usually be made which will give the proper operating conditions. For example, if it is found that the winding is connected series-star as in Fig. 4, and the motor is connected for 440 volts, when it is to be operated on a 220-volt circuit the winding

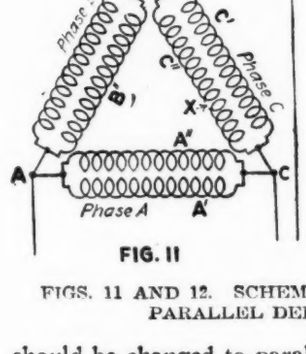


FIG. 11

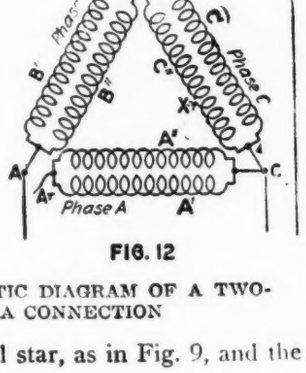


FIG. 12

FIGS. 11 AND 12. SCHEMATIC DIAGRAM OF A TWO-PARALLEL DELTA CONNECTION

should be changed to parallel star, as in Fig. 9, and the operation will be normal.

Ninth Fault: The easiest way to detect a connection for the wrong number of poles is to run the motor light and take the speed with a tachometer or speed counter. When it is found that the winding is connected for the wrong number of poles, the possibility of reconnecting can be determined by methods suggested in the articles on "Changing Number of Poles," in the Apr. 9, 1918, Aug. 20, 1918, and Jan. 7, 1919, issues.

Tenth Fault: Open-circuits are manifest from the fact that the motor will not start, but acts as if it were operating single-phase. It is easy to determine, in a star-connected winding, in which phase the open-circuit exists by connecting all phase leads to the starting transformer and opening them one at a time to see in which lead no current is flowing. In Fig. 10 assume that the open is in phase *C* at *X*. Then if lead *A* is open, no current will flow through the motor, since the path is from *B* to *C* and is open at *X*. If the *B* lead is disconnected with *A*, and *C* connected, no current can flow, since the *C* phase is still in circuit. If *C* is disconnected with *A* and *B* lead connected in circuit, then *C*, the defective phase, will be cut out of circuit and current will flow in the *A* and *B* windings of the motor and it will act as if operating single-phase, which will be indicated by the motor emitting a humming sound. When the defective phase is located, it is not always apparent just where the break is. A visual inspection may fail to show the break on account of tape over the defect or for some other reason. If this point cannot be located by inspection, a simple method of finding it electrically is indicated by referring to Fig. 10. A test voltage somewhat lower than normal or whatever is convenient is then applied to *B* and *C*, and a suitable voltmeter is used to measure the voltage between *B* and various points along the *C* phase, as, for example, 1, 2 and 3, which are chosen at random along the "stubs," or coil-to-coil connections, or on the group cross-connections, as in the figure. With the condition as shown in Fig. 10, assume that 110 volts has been applied to the *B* and *C* terminals of the winding, as shown. If one lead from the voltmeter be attached to *B* and the other lead touched successively to *C* and 1, 2 and 3, the voltmeter will read 110 volts between *B* and *C*, *B* and 1, *B* and 2, and zero volts between *B* and 3, since the *C* phase is open at *X*. The conclusion is immediately and properly reached that the break is between 2 and 3 and with the inspection narrowed down to this small section of the winding the break is usually apparent. However, should the break not be discovered by inspection, points can be selected with finer steps between 2 and 3 and voltage readings taken until the defect is narrowed to the exact coil or piece of cross-connection where it exists.

In the case of a delta connection one of the simplest ways to detect an open-circuit would be to open the connection at one terminal of the delta, such as *A* in Fig. 5, and connect a test circuit across the open. If the winding is open no current will flow. The phase with the open in may be located by testing across each phase separately. If a lamp is used to make the test, the defective phase will be indicated by failure of the lamp to light. After the faulty phase has been located, the location of the defect can be determined as for the star connection, Fig. 10. There are all manners of parallel-star and other groupings in which it is difficult to locate an open-circuit, since an open in one parallel group does not open the circuit through the phase, but in only one of the parallel groups. For example, in Fig. 11 an open in phase *C* at *X* will not open the phase between terminals *B* and *C*, but only through *C*." Therefore, to detect the open group it will be necessary to break the winding up into its parallel groups and test each group separately. The defective phase could be detected by the balance test as previously described. First, open the delta connection, for example, at *A*, Fig. 12, then apply the low-voltage alternating current between points *A* and *B* and measure the current with an ammeter, test between *A* and *B*, *B* and *C* and between *C* and A_1. The phase with the open circuit, which in this case is *C*, will show a lower reading than the other two phases, after which all that is necessary is to break the phase up into its parallel groups and test the defective group for opens, as explained in Fig. 10.

These are the defects that commonly occur and the usual method of locating them. In checking for these defects the order usually observed is as follows: After the winder has completed the connection of the entire winding, his work is checked, preferably by a second winder, against the winding diagram specified for that particular job. The coils per group are counted and a visual inspection made for short-circuits, open circuits and reversed coils, groups or phases. A balance test is made on the stator alone with low voltage to see if, roughly, the same current flows in the various phases. A high-voltage test is then made on the insulation to insure that the coils are not grounded on the iron core, or that there is no short-circuit between the conductors of the different phases. If everything is satisfactory up to this point, the rotor is then assembled in the stator and the machine prepared for a running test. The resistance of the winding is measured on all phases, and if alike, the machine is passed for running test without load. Sufficient voltage is applied to start the rotor, and if it comes up to speed quickly without apparent distress or irregularity of any kind, the speed is checked to verify whether the winding has the proper number of poles. The temperature of the winding is then tested with the hand, passing completely around the machine and using care that the rotating member and its parts do not strike the observer. If neither general heating nor hot spots are observed, the voltage is raised to nor-

mal and the no-load current in all phases and the total watts are read. If these values check with the previous tests on similar machines or with calculations, the windings are considered to be correctly connected. If the motor does not readily come up to speed or the phases do not balance or there are signs of unequal heating in the winding or other distress, the rotor is removed and the connections again checked. If the error is still not apparent and a source of direct current is available, the compass test may be applied. Having exhausted this resource without avail, the problem is one that can be solved only by some expedient at the command of an experienced designing engineer, but such appeals are very seldom required, as the trouble usually appears from the simple tests described.

Shaw Monolith Suspended Boiler Arch

The Shaw suspended boiler arch, a design that does away with a multiplicity of small bricks, has been developed, and is put out by L. S. Shaw & Co., Union

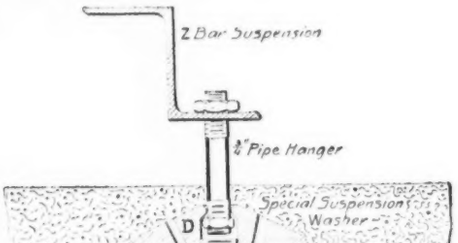


FIG. 1. DETAILS OF HANGER

Building, Cleveland, Ohio. This arch can be constructed flat or with any desired curvature or shape by simply turning the nut on the suspension bolt.

In Fig. 1 are shown the details of the hanger, which consists of a ventilated cast-iron disk suspended by

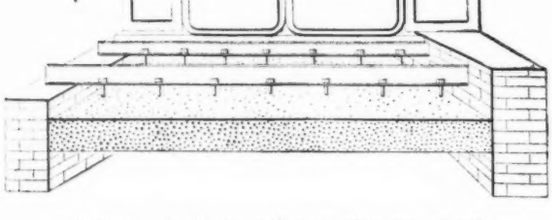


FIG. 2. FLAT-SURFACE BOILER ARCH

means of a ¾-in. pipe from supporting beams, each disk carrying about 200 lb. load.

The arch proper consists of a compounded firebrick material of silica and alumina fireclay heavily charged with asbestos fiber and free from expansion and contraction. Thus it is not necessary to form expansion joints. It is necessary to form contraction joints, which, after the arch material has been baked, are filled with fireclay. These joints are three feet apart and form a natural lamination which allows for easily removing a section of the firebrick when repairs are necessary.

The monolith arch is adapted to all furnace design and irregularities in construction, as it is only necessary to build side walls and fill in between, with the forms centered, with the firebrick mixture, and then bake it in position, as shown in Figs. 2 and 3, the former indicating a flat surface and the latter view an irregular one.

The shape of the temporary form is made by screwing a 1¼-in. adjusting pipe *A*, Fig. 1, that is supported by the channel *B* and supports the expanded metal *C*. After

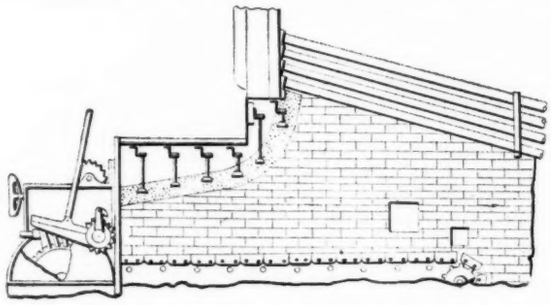


FIG. 3. IRREGULAR BOILER ARCH

the brick is baked, the pipe *A* is removed from the disk *D*, leaving the pipe hole, which can be filled with brick. When the brick requires repairs, this pipe *A* is screwed into the disk to support the centering form, which is filled with brick and then the pipe is removed.

It will be seen that this monolith form of arch has a simple beam construction, but one type of casting and firebrick, the whole being simple to build, easy to repair and requiring ordinarily but a few repair parts to be kept on hand.

Combustion at Low Speeds with Semi-Diesel Engine

For many years the inability to guarantee satisfactory running of semi-Diesel engines at slow speed and light load was an important factor in limiting the number of this type of engine installed for marine purposes. The difficulty was due to the impossibility of keeping the vaporizer sufficiently hot to insure combustion when the engine was running slow and without load. This trouble has been overcome by the Vickers-Petters patent light-load running gear, which permits the injection of fuel very much in advance of the normal point of injection.

The arrangement is carried out by making a connection in such a way that one fuel pump delivers fuel to two cylinders at each stroke. One part of the charge is injected into the cylinder normally supplied, and at the normal timing, while the other part is injected into the other cylinder in advance of the normal timing. The early injection is a light one and burns in the combustion chamber, maintaining sufficient heat there to insure proper combustion of the normal charge. The change over to this light-load device is made easily and at any time by a small hand lever. The main injection is in no way interfered with and the governor is still in action. Should full load be suddenly applied the governor at once assumes its duties and regulates the fuel accordingly.—*Engineering*, London.

Refrigeration Study Course—V. Ammonia Fittings and Accessories

By H. J. Macintire
Professor Mechanical Engineering, University of Idaho

ENGINEERS who are familiar with steam and the operation of steam boilers and engines should have no trouble with refrigerating apparatus or the operation of an ammonia system. For example, the fireman has two things of major importance to care for—water regulation and combustion control. The engineer has one big fear, namely, the effect of water in the steam line and in the engine cylinder; and a lesser one, perhaps, the matter of lubrication. Let us see how this compares with the refrigerating system.

The expansion valve controls the liquid feed into the refrigerating or cooling coils. The amount of gas boiled from these coils depends on the manner of operation and the amount of feed. But it is just as easy to bring back a slug of ammonia to the compressor as it is to bring water into the steam engine. Also, in opening a valve one should expect an accumulation of liquid ammonia back of it as easily as in a cold steam pipe. Similarly, low points in the pipe line should be provided with drains and certain other parts with modified separators. There is not the same danger of liquid hammer on the pipe line and fittings of the ammonia system only because the load does not tend to fluctuate suddenly, as a steam engine is likely to. However, when trouble does occur, it is much more serious on account of the peculiarities of ammonia. There are other troubles, however, such as increase of pressure due to rise of temperature, difficulty in maintaining tightness at all times, removal of oil and water, foul gases, etc.

The Ammonia Line Must Be Made Tight

Ammonia has the property of escaping through piping and fittings which would be absolutely tight for steam. The result is that the material used must be special or must be of high grade and very thick. Screwed fittings are made tight in two ways: Either by tinning and soldering, or by making up with a paste of litharge and glycerine. Flanged fittings are made with a special design. The faces are fitted on a lead or rubber gasket placed inside of the groove. When properly erected, an ammonia line can be made perfectly tight.

The material used for ammonia is undergoing a steady change. Where ordinary cast iron is still used it has to be very thick, but most manufacturers are taking to the use of air furnace iron, semi-steel or (in the case of fittings) drop-forging. The drop-forged ammonia fitting is becoming widely used in spite of its additional cost.

Headers and receivers are now made of steel, usually flame-welded, both as regards the longitudinal seam and headers, and also in respect to the nipples and outlets. The finished product is light in weight, moderate in price and (if the work is properly executed) amply strong. The flame-welded shapes may be made readily for any design, as it is a matter only of cutting out the steel plate and rolling to form.

The kind of pipe to be used is still a question for debate, with the use of black steel pipe gaining in the race. For certain special work where corrosion is likely to occur, it is becoming the custom to specify extra-heavy steel pipe in preference to wrought-iron pipe. In fact, there are so many factors which cause corrosion that it is fairly doubtful as to just what kind of pipe is least affected. Both lap- and butt-welded pipe are used, there being no particular difference if the finished product is carefully inspected and tested.

Oil Traps Should Be Provided

One of the most serious operating troubles is due to the effect of oil. Most operators feed the lubricating oil too heavily, but the more recent designs for high-speed compressors require considerable lubrication. If oil gets out of the cylinder (and it will), it should be separated from the hot, compressed gas before it enters the condenser. In consequence an oil separator is placed in the line, preferably nearest the condenser. However, no oil separator is perfect, because some of the oil is vaporized by the heat, and oil will pass into the condenser and will ultimately find its way into the liquid line and expansion piping. Of course, oil in expansion piping (or any other heat-transfer piping) is almost as bad as if it were in boiler tubes. The efficiency of the piping is reduced, and the coils will lose capacity. In consequence it is wise, wherever there is a low point in the expansion piping, to place a trap for the collection of the oil. These traps may be connected together and all run into the purifier, or they may drain into the atmosphere.

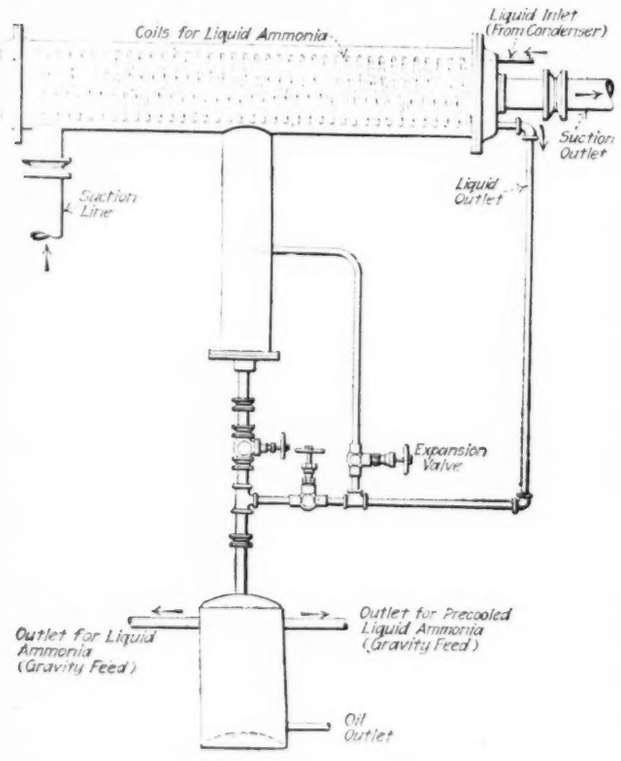
The refrigerator, or purifier, is an arrangement which is absolutely necessary for plants of moderate size. The piston rod, being cold, has moisture from the air condensed on it, and this, in time, gets into the refrigerating system, being carried in by the movement of the piston. Water will make ammonia "dead," and after a time satisfactory results are impossible. In consequence it is necessary to renew the ammonia charge by pumping out the entire system and recharging, or to use a special device. This latter is an arrangement by which a small amount of liquid ammonia is bled off from the high side, or from the traps, into a special drum usually arranged for heating by means of hot water or steam coils. Liquid ammonia is bled off regularly and is heated sufficiently in the regenerator to boil off the ammonia which passes to the suction of the compressor. The water and oil are left behind as a residue.

Function of the Accumulator

Every steam engineer knows the test for the water level in the boiler by use of the gage-cocks, and each engineer has his own idea of the reason for the fact that, when water is allowed to blow out, it appears as a wet steam. Apparently, water has flashed into steam on being allowed to escape into the atmosphere.

As a matter of fact, the water in the boiler contains more heat energy at boiler pressure than is permissible at atmospheric pressure. As the water reduces in pressure on passing the gage-cock, the surplus heat energy vaporizes some of the water, and therefore the appearance of steam.

The expansion valve has been misnamed; it really is only a pressure-reducing valve. As the liquid ammonia is fed through the valve, the pressure drops from, say, 150 lb. to about 15 lb. or whatever the suction pressure may be held at. The heat in a unit weight of liquid ammonia at 60 deg. F. is much greater (because of its temperature) than a similar weight of liquid ammonia at 0 deg. F. In consequence the ammonia, on passing the expansion valve, has the same effect take place as with the gage-cocks, and some ammonia will be vaporized. This ammonia de-



GAS PRECOOLER CONNECTIONS

pends on the temperatures of the liquid on the two sides of the expansion coils and may be less than 10 per cent, but usually it is between 10 and 15 per cent. The vapor formed is of no practical value for refrigeration, and the sooner it is gotten rid of the better it will be. In consequence, in certain cases a special device, called an accumulator, is used.

The accumulator is a special trap, arranged so that not only is the gas formed by the process of the reduction of pressure returned directly to the compressor, but it acts also as a separator and insures against liquid returning to the machine. In one design, shown in Fig. 1, it is seen that there are two parts, the upper acting as a kind of precooler and suction-gas drier, and the lower as a separator for the vapor and liquid and the lowest part as an oil collector. It is noticed that the whole trap is open to the suction pressure and that the liquid ammonia flows to the expansion (refrigerating) coils by gravity. In consequence, sufficient head must be allowed to force the liquid into the coils, which are fed from the bottom and are called "flooded." A flooded system of refrigerating coils is not exactly as its term would indicate. As soon as the liquid enters the refrigerating coils, evaporation (and refrigeration) begins and gas is given off. This gas passes on up through the pipe and finally gets into the suction pipe. So the coils are all liquid at the beginning and all, or nearly all, gaseous at the top. The advantage of the flooded system is in the initial removal of the gas in the accumulator and the easy control of the feed into the cooling coils. The coils are much more efficient in this system, but as a rule it can only be used in ice tanks or special piping where a gravity head may be employed.

Pump-Out Lines Should Be Provided

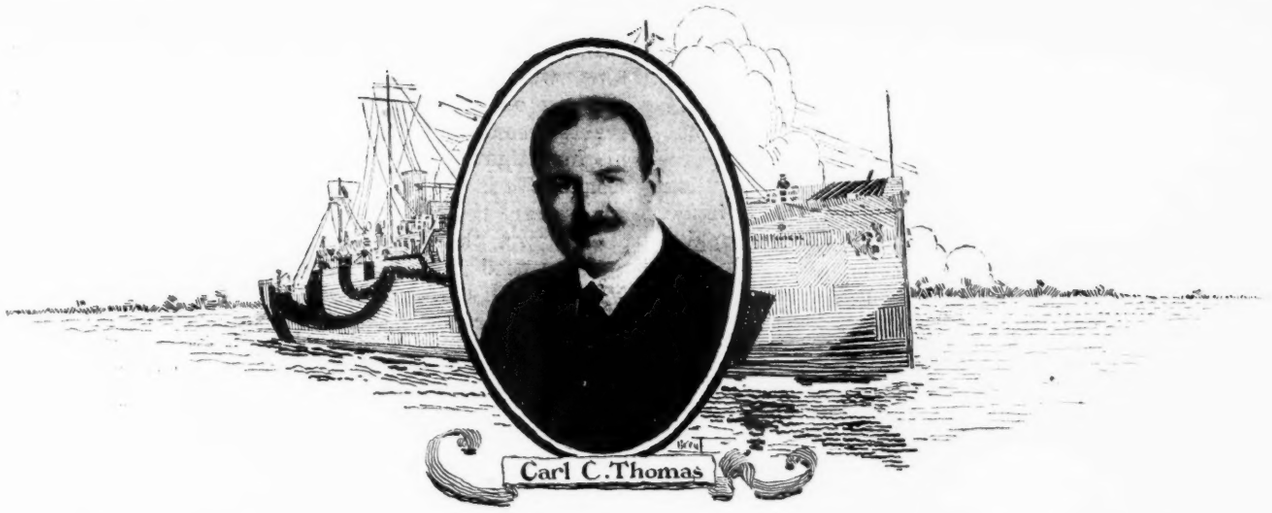
To make repairs or alterations it is required that means be provided to remove the ammonia charge from the part of the system in question and store it in another part. In consequence, "pump out" lines are provided. These pipe lines leading back to the compressor need not be of full size pipe, as it is expected that only small coils or a few stands of pipe will be pumped out at a time.

To pump out the high side easily it is customary to have cross-connections on the compressor. These are means by which the discharge from the compressor is delivered to the suction pipe and the suction is drawn from the high side. The suction and discharge stop valves are closed tight, and these bypass valves are placed on each side of the stop valves. In addition, on account of necessity for freedom in starting electric-driven compressors, a full-sized bypass frequently is made between the discharge and suction pipes. This is really just a "short-circuit" so as to reduce to a minimum the power required on starting.

Suction-Line Scale Trap

On erection the pipe line is carefully blown out to clear of mill scale, etc., but during operation some scale, dirt, foundry sand, etc., will become loosened and will flow back to the compressor. The poppet type of valve is ground to a "line" contact, and other forms are ground to a surface fit. It is clear that impurities of all sorts must be kept out of the cylinder and valves. A leaky valve means much-reduced capacity. Therefore, a scale trap is placed in the suction line near the compressor, where it may be cleaned readily.

The extent to which fuel oil is used in the United states may be inferred from the fact that more than half of the total yearly consumption of petroleum is utilized as fuel for steam raising, this including not only the fuel oil produced by the refineries, but the oil used in its crude state. The whole southwestern part of the United States is dependent on oil fuel, because of the absence of coal fields, and there has been a marked increase in the use of liquid fuel in the New England section because of industrial expansion brought about by war activities. War demands placed a heavy burden on the oil industry, and the rate of consumption greatly exceeded the rate of production. During 1918, according to the statistics of the Geological Survey, the total marketed production of crude petroleum in the United States was 345,986,000 bbl. of 42 gal. each. In the same time the consumption amounted to 367,489,000 bbl., indicating that the domestic production fell behind the consumption.



An Educator, Engineer and Executive

What Professor Thomas Thinks of the Future of Marine Propelling Machinery

Many ships propelled by steam turbines and reduction gears have been put in service within the past two or three years, and valuable information as to durability and economy of operation is now in existence. It is very desirable that this be made public for the guidance of engineers and ship owners. My personal view of the matter is about as follows:

Several types of geared turbine equipment have given exceedingly satisfactory results, but there is considerable reason for questioning the ultimate desirability of gearing. Fuel economy of the main propelling unit alone does not necessarily control the over-all cost of operation, and many reciprocating engine ships are still relatively satisfactory in this respect.

The steam-turbine-electric drive, with water-tube boilers and oil fuel, appears to offer the only solution for navy and passenger vessels of above 30,000 or 40,000 hp., though the steam turbine and single-reduction-gear drive is well adapted for such vessels having less power than those named.

For cargo vessels where the power is from 2,000 up to perhaps 6,000 hp., the best solution appears to me to be the heavy-oil engine with electric drive. Two oil engines can readily be installed in a single-screw ship, to drive generators at approximately constant speed. The arrangement would be quite flexible with regard to overhaul and maneuvering, as either engine alone would ordinarily be available for propulsion. The fuel and space economy with such an arrangement should be very good as compared with a steamship, although the cost of engine-room service would probably be greater. A great advantage in using electric drive in connection with oil engines is that the engines can be built to rotate always in one direction—the motor on the propeller shaft being reversible.

An alternative arrangement has been proposed consisting of two heavy-oil engines direct-connected to two sets of propeller shafting. This would be, in some respects, simpler than two oil engines with electric drive and single screw, but, on the other hand, the propellers would be smaller and in more exposed position with twin screws, and the first cost of the vessel would be considerably higher. The choice for oil-engine-driven cargo vessels seems to lie, however, between these two types, pending the probable development of relatively large engines suitable for direct drive.

The use of the geared turbine drive during the war emergency was undoubtedly justified because, at the time contracts were let, turbines and gears could be manufactured much more quickly and in greater numbers than reciprocating engines.

TO BE a successful teacher, practicing engineer and executive requires a combination of qualities possessed by few—in fact—so few that they can easily be singled out in the engineering profession. Among such men will be recognized Carl C. Thomas, head of the Department of Mechanical Engineering at Johns Hopkins University, Baltimore, and more lately identified with the achievements of the great Hog Island shipyard, where, since the early days of the war, he was in charge of the Engineering Department, and as such had supervision over the fabrication of machinery going into our merchant fleet.

This involved responsibility for the organization of the department, the designing of all machinery and equipment for the ships, and specifying for their purchase. The equipment was supplied by over 3,000 firms widely scattered throughout the country, and it was necessary to furnish them complete detailed drawings and specifications, as well as to inspect the work in the most careful manner. An interesting feature of the work was the erection in two special buildings on the Island of one complete set of machinery, boilers, piping, etc., for each type of ship. This was done before the first hulls were ready to receive their machinery, in order to make sure that all the parts manufactured in different parts of the country would fit together according to the design. This templet shipwork proved to be of great value in checking up the material received.

Born in Detroit, Mich., July 14, 1872, of old New England stock dating back to 1631, the subject of this sketch chose mechanical engineering as a vocation and entered Cornell University, from which he graduated with the class of 1895. Shortly after graduation he became identified with the Globe Iron Works, shipbuilders, of Cleveland, and later was chief draftsman of the Marine Department of the Maryland Steel Co., leaving there in 1901 to join Moran Bros., shipbuilders, of Seattle, Wash. Fortified with this practical experience, he entered upon a teaching career and became professor of marine engineering at Cornell University, succeeding Prof. W. F. Durand, when the latter was called to Leland Stanford, Jr., University. After four years at Cornell Professor Thomas accepted

a call to the University of Wisconsin as head of the Department of Mechanical Engineering, and remained there for five years, leaving in 1913 to organize the newly created Department of Mechanical Engineering at Johns Hopkins University. When the war broke out, he joined the American International Shipbuilding Corporation at Philadelphia, remaining with that concern until some months after the signing of the armistice. He has since returned to his work at Johns Hopkins University.

As a teacher Professor Thomas has the faculty of interpreting engineering problems, in a practical sense, and many of his former students will recall that he was always at his best when in the midst of a small group of boys at a drawing board laying out some problem in design. His approachability and the fact that he has always dealt with his students as men accounts in no small sense for his success as a teacher. Professor Thomas could never be accused of having a single-track mind, for he is never content unless directing several projects at the same time. While engaged in the teaching profession, he did much consulting work, especially in the early days of the turbine, was author of the first book written in this country on steam turbines, and carried on considerable research in the university laboratories, notably his investigation into the specific heat of superheated steam. He is the inventor of the widely used Thomas gas meter, the Yarway adjustable spray head and other power-plant appliances, as well as a mechanical agitator used in process work in various chemical industries.

He has for a number of years taken a prominent part in the activities of the American Society of Mechanical Engineers and is a member of the American Society of Naval Architects and Marine Engineers, the American Gas Association, the Engineers' Club of New York, the Engineers' Club of Philadelphia, the University Club of Philadelphia, and the Phi Gamma Delta Fraternity. He has also had membership conferred upon him in the honorary fraternities of Tau Beta, Sigma Psi and Phi Beta Kappa.

Repairs Made by Electric Welding

ACCORDING to the general rule governing the acceptance of autogenous welding, paragraph 186 of the Boiler Code of the American Society of Mechanical Engineers, states that autogenous welding may be used in boilers in cases where the strain is carried by other construction which conforms to the requirements of the code and where the safety of the structure is not dependent upon the strength of the weld.

In *Power*, page 40 of the Jan. 6 issue, an article was published regrading the attitude of the Steam Boiler and Flywheel Service Bureau in reference to autogenous welding. This committee is made up of engineers of all the insurance companies in the United States that are writing steam-boiler insurance. All welding accomplished by oxyacetylene, hydrogen or other flame processes, or by electric arc comes under the head of autogenous welding.

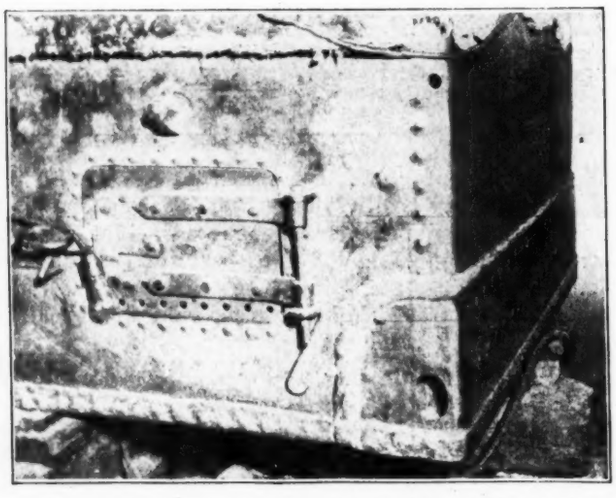


FIG. 1. PATCH WELDED TO WATER LEG OF A LOCOMOTIVE-TYPE BOILER

The accompanying illustrations show several welding jobs that have been done by the S O S Welding Corporation, of Brooklyn, N. Y. Figs. 1 and 2 illustrate a welding job that was recently completed on one of two boilers at the Republican Club, West 40th St., New York City. This boiler is of the stationary locomotive type and is rated at 150 hp. The firing doors are on one side of the firebox, the grates running crosswise. As originally set, the front, back and end of this firebox were bricked in to form an ashpit, the side below the firing doors being of cast iron and fitted with clean-out doors.

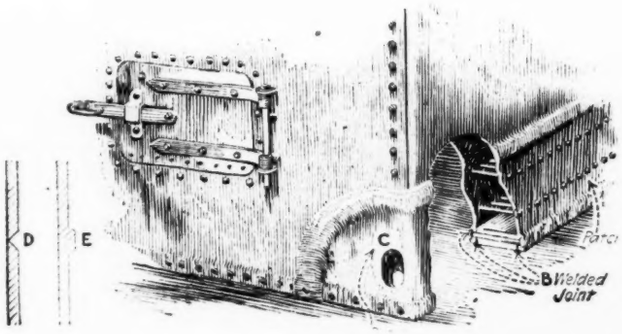


FIG. 2. APPLICATION OF PATCH AND POINTS OF WELDING

It was found that the plates and rivets of the bricked-up portion of the boiler water leg had so corroded at the joints that it was impossible to calk the seam *B*, Fig. 2, sufficiently to keep them tight, and on the advice of the inspector from the Employers' Liability Association Corporation, Ltd., of London, the outside end plate of the water leg was cut out for a distance of twelve inches above the bottom of the mud ring and a patch *C* welded on. This patch is of the same thickness and material as the original plate which is $\frac{7}{16}$ in. thick. This plate turns the corner of the boiler for a distance of twelve inches, the joint

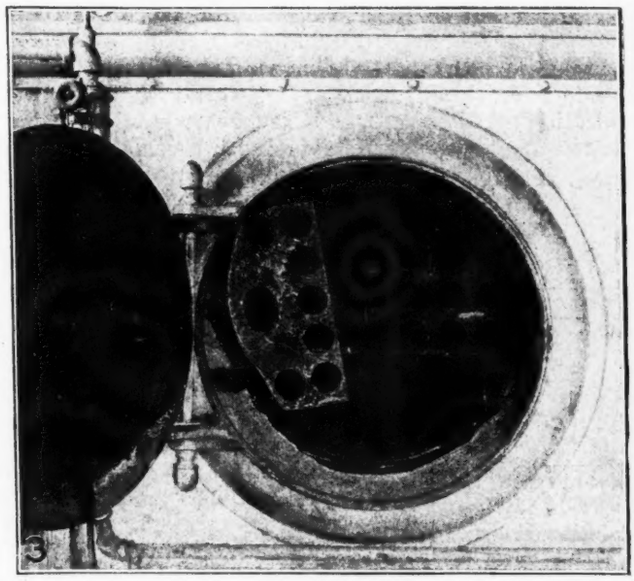


FIG. 3. PATCH THAT IS TO BE WELDED IN TUBE SHEET

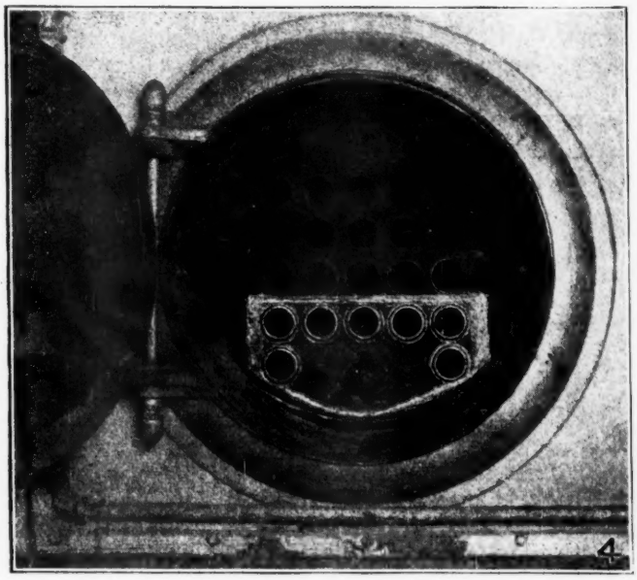


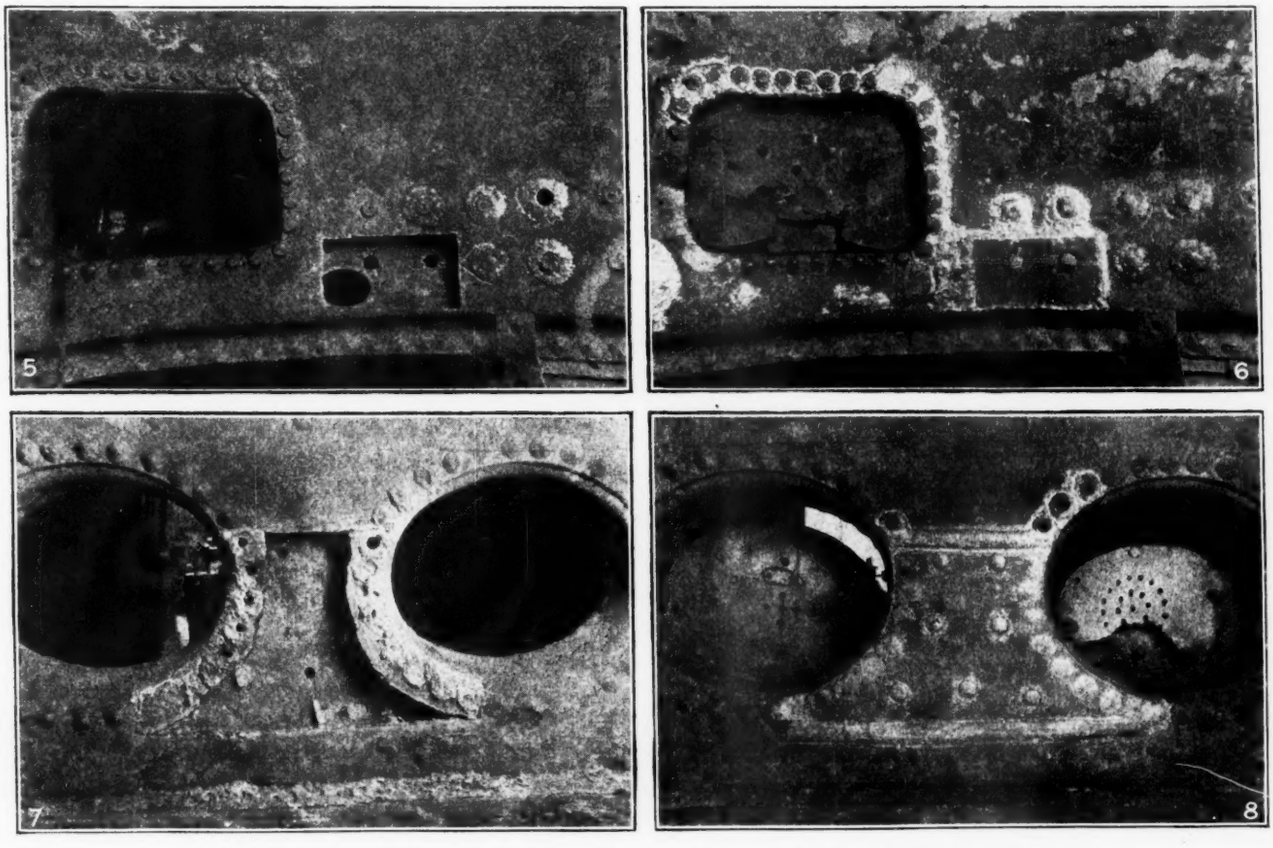
FIG. 4. PATCH SHOWING WELDED JOINT IN TUBE SHEET

at the back and front ends being made curved instead of with a sharp corner.

The plate and patch were first cut V-shape with the outside surface as shown at *D* and spot-welded to hold it in position. The V-groove was then filled in by the electric welding process. After filling in the groove between the plates, welding material was built up, making the welded surface on the outside of the plate three inches wide, as shown at *E*.

As the mud-ring rivet heads had corroded, welding material was applied along the rivets on all sides of the water leg, coming flush with the head and three inches wide. The under joints between the plate and the mud ring were also welded.

The boiler will carry ninety pounds pressure the same as before repairs were made. The entire repair bill will, it is estimated, be about one-third of what a new boiler would have cost and what would have been necessary to purchase if repairs had not been made by welding. Another boiler is also being welded.



FIGS. 5 TO 8. SHOWING DEFECTIVE BOILER BEFORE AND AFTER WELDING

The several other welding jobs illustrated were performed by the same company. The one shown in Figs. 3 and 4 was made to a return-tubular heating boiler. Fig. 3 shows the defective parts cut out and Fig. 4 the welded portion in place. This work was performed

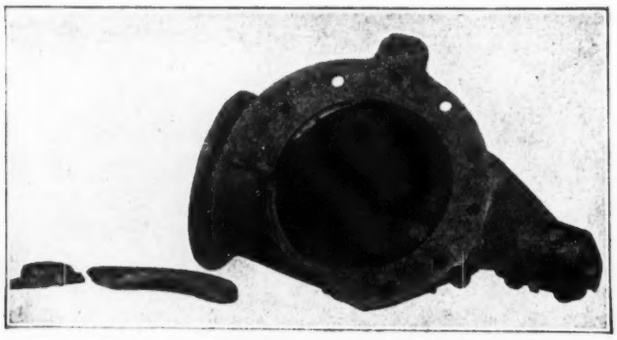


FIG. 9. BROKEN PUMP CASTING

on both the front and back tube sheets of the boiler. This repair was made necessary on account of the corrosion taking place around some of the tube holes.

In another instance the wasted fire sheet of a vertical boiler was cut out and a new piece welded in as shown in Figs. 5 and 6. In this instance the wasted plate around the stay-bolts was built up by electric welding. Several rivet cracks and leaky rivets around the door frames were also welded by the same process. When the repairs were complete, the boiler carried its original pressure.

Another weld is shown in Figs. 7 and 8. In this case the sheet between the firedoors had wasted away. The wasted portion was cut out as shown in Fig. 7,

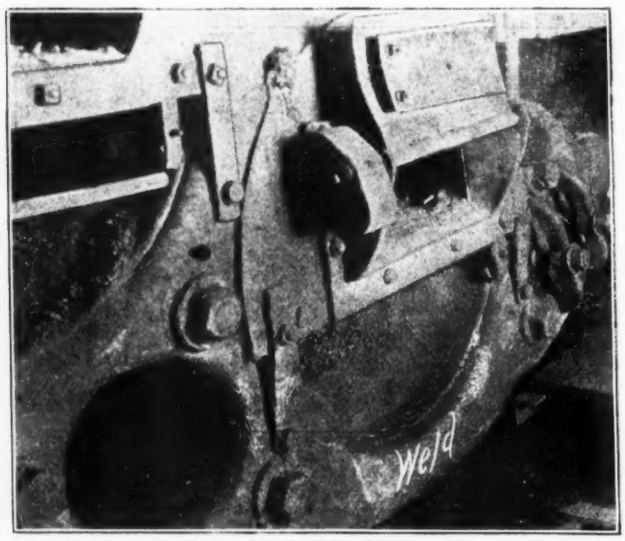


FIG. 10. CRACK 36 IN. LONG WELDED IN FRONT HEAD OF SCOTCH-MARINE BOILER

and a new piece of plate welded in place as shown by Fig. 8. The welding around both firedoor openings replaced the rivets altogether.

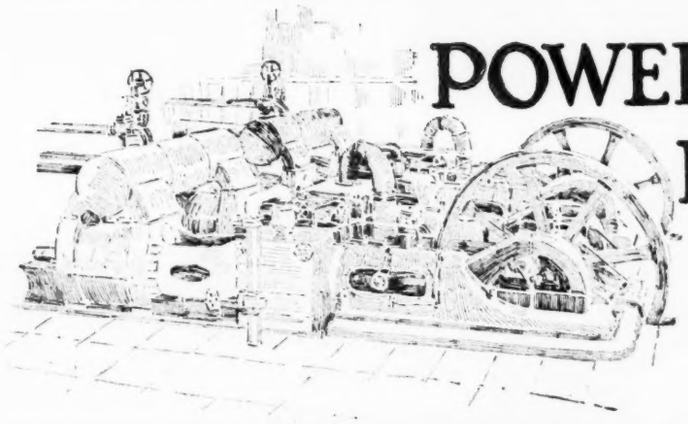
A neat weld is shown in Fig. 10. The original defect consisted of a crack 36 in. long in the front head of a Scotch marine type of boiler, next to the flanged edge of the head. This was electrically welded over night while the steamer was being unloaded, thus obviating any delay in sailing.

The art of welding has reached a stage whereby practically all kinds of repair work is being done, and many power plants own and operate a welding outfit for making their own repairs. An instance of casting welding is shown in Fig. 9. This was a casting forming the inlet and outboard bearing of a motor-driven pump, the flange having been broken as shown, by Fig. 9. The broken parts were welded in place,

FIG. 11. WELDED OUTBOARD PUMP BEARING IN PLACE AFTER WELDING

no drilling or studding being done, and the repaired casting was put back in place on the pump as shown in Fig. 11.

With any fuel the mixture must be compressed within the engine cylinder before it is ignited, for the compression adds greatly to the efficiency of the fuel and increases the output of a given size cylinder. All other things being equal, the output and efficiency increase with the compression within certain limits. The degree of compression which it is possible to carry depends upon the character of the fuel to a great extent. Very rich fuels, such as kerosene, start cracking and preigniting at very low pressures, 80 lb. per sq.in. probably being the limiting pressure for kerosene. In aëronautic engines the compression is carried to the highest possible point so as to obtain the maximum output. This maximum is reached at a pressure approximately of 130 lb. per sq.in. with gasoline. With very lean gases, such as producer gas, or blast furnace gas, much higher compressions are possible, the pressure for producer gas probably averaging 240 lb. per sq.in. while 400 lb. per sq.in. is not uncommon with blast furnace gas. When the compression is carried up to too high a point with any fuel, explosion waves are started which rack the structure of the engine and cause excessive wear. The fuel is then decomposed so as to form deposits of solid carbon. This carbon becomes incandescent later on and starts preignition and other troubles. In many cases, the efficiency of a fuel is limited by the limiting compression pressures which it is possible to use. The preignition causes violent hammering for the direction of the stresses are reversed.—*Exchange.*



POWER DRIVES FOR ROLLING MILLS

By W. O. Rogers

Air is provided for the blast furnace by huge steam-driven, air-blowing engines. Some of these are of the horizontal and others are of the vertical type. In other instances gas-engine-driven blowers are used, and in still other plants turbo blowers produce the blowing air.

OF EQUAL importance with engines of various types used in the manufacture of steel are the blowing engines, and it is doubtful if in any other industry the use of compressed air is of so much importance. As stated in a previous article, compressed air is used in the blast furnace and with the bessemer converters. The air that is supplied to blast furnaces is forced into the furnace by extremely large blowing engines, some of which are of 2,500-hp. capacity and capable of compressing from 30,000 to 65,000 cu.ft. of free air per minute to a pressure of from 15 to 30 lb. per sq.in., which is about what one blast furnace requires. After leaving the compressor, the air is heated to between 800 and 1,200 deg. F. by being made to pass through hot-blast stoves. In the bessemer process about 30,000 cu.ft. of cold air is forced through the molten material per minute.

Most blowing engines are steam-operated. At the main plant of the Youngstown Sheet & Tube Co. there are four 88, 90 and 96 by 72-in. 2,500 hp. Tod engines in one plant, each with a capacity of 48,000 cu.ft. of free air per minute at 40 r.p.m. compressing to from 10 to 20 lb. per sq. in. Fig. 2 is a view of one of these engines taken from the crank end. The Corliss steam cylinders are arranged cross-compound and are placed next to the engine frame, the air cylinders being placed at the head end of the machine.

Fig. 1 is a general view of the blast-furnace blowing room and shows the four blast-furnace blowing engines, also two Southwark-Rateau turbo-blowers driven by a 3,500- and 5,000-kw. turbine, respectively. Fig. 3 is a view of the 2,000-hp. unit which at 1,650 r.p.m. has a capacity of 40,000 cu.ft. of free air per minute, compressed to from 10 to 20 lb. per sq. in. It is equipped with a stabilizing device for preventing back flow when small quantities of air are being blown and with a Rateau multiplier for maintaining the delivery of air constant, irrespective of the pressure.

At the Republic Iron & Steel Co. plant, I found several Allis-Chalmers blowing engines of the steeple type, used to supply air to blast furnaces. These are shown in Fig. 4. These engines were of different design. For

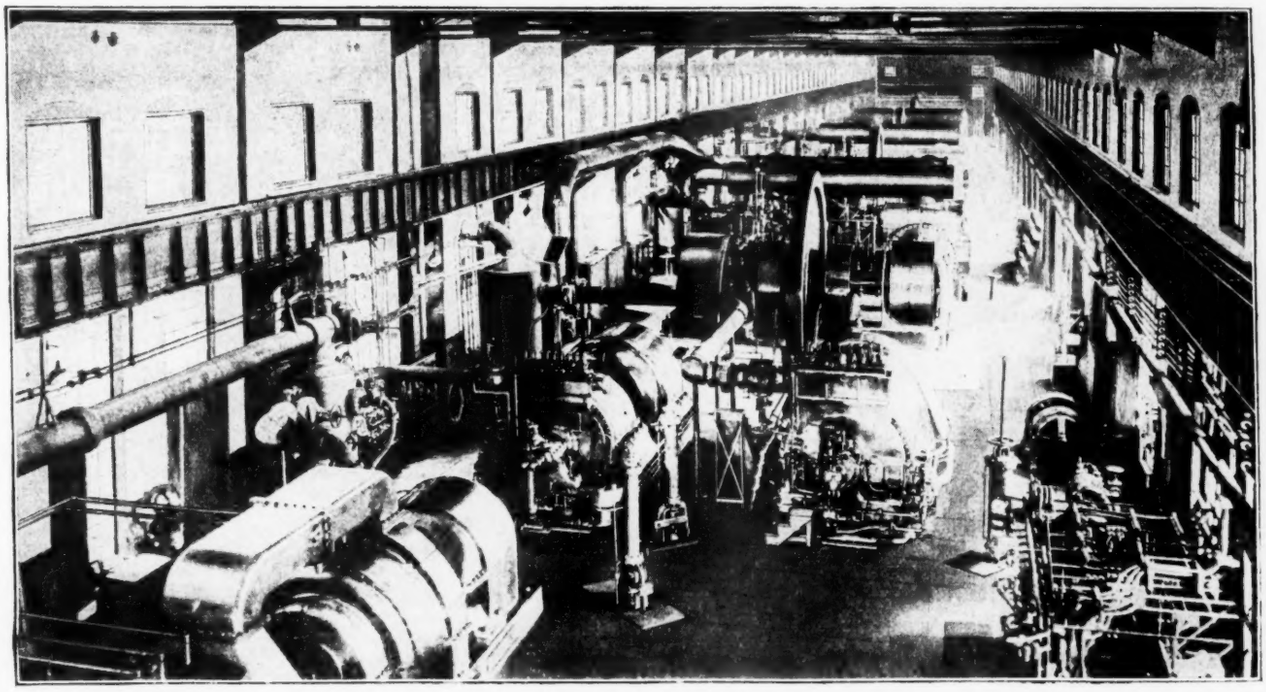


FIG. 1. GENERAL VIEW OF BLAST-FURNACE BLOWING ROOM AT THE YOUNGSTOWN SHEET AND TUBE COMPANY

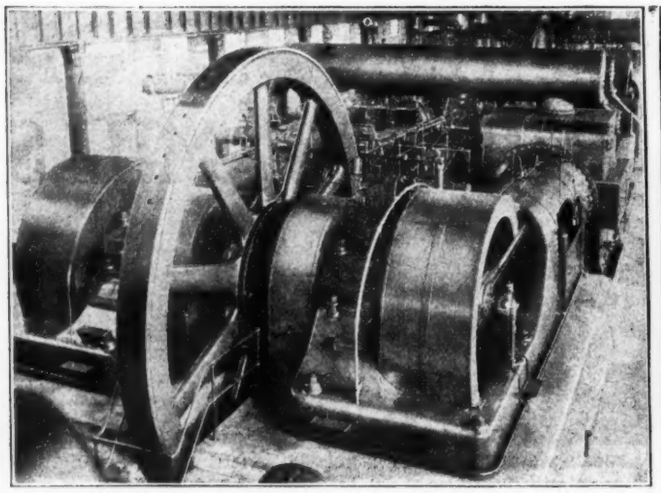


FIG. 2. ONE OF THE 48,000-CU.FT. 2,500-HP. CROSS-COMPOUND BLOWING ENGINES

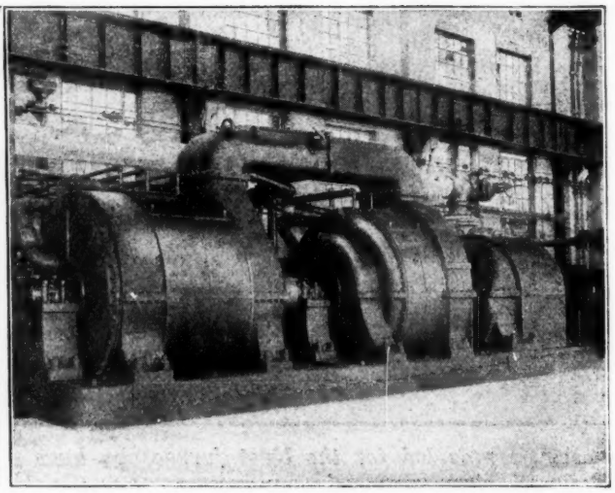


FIG. 3. A 40,000-CU.FT. TURBO-BLOWER, 2,000-HP. CAPACITY

instance, there were three high-pressure and two low-pressure vertical long crosshead type units having 52 and 96 x 60-in. high- and low-pressure cylinders, each having 96 x 60-in. air cylinders. Each of these blowers has a capacity of 20,000 cu.ft. of free air per minute at 41 r.p.m., or running as a pair of disconnected compounds—that is, one high- and one low-pressure unit—each pair would have a capacity of 40,000 cu.ft. of free air per minute. Fig. 5 shows a standard long-crosshead engine and Fig. 6 a long-crosshead low-pressure unit.

The high-pressure units are arranged to exhaust into a receiver from which the low-pressure engines take their steam. This arrangement is such that any high-pressure engine can run with any of the low-pressure engines. Some idea of the size of these engines can be had from the following: The main bearings are 21 in. in diameter by 28 in. long. The crosshead and crankpins are 12 in. in diameter by 10 in. long and the flywheels are 24 ft. diameter and weigh approximately 60,000 lb. each.

There were also two high- and two low-pressure vertical long-crosshead blowing engines with 44-in. high-pressure and 84-in. low-pressure cylinders each having 60-in. stroke and both having 84 x 60-in. air cylinders. Each of these machines has a capacity of 20,000 cu.ft. of free air per minute at 55 r.p.m., or a capacity of 40,000 cu.ft. per min. for each high- or low-pressure machine.

These blowers are also arranged so that either high-

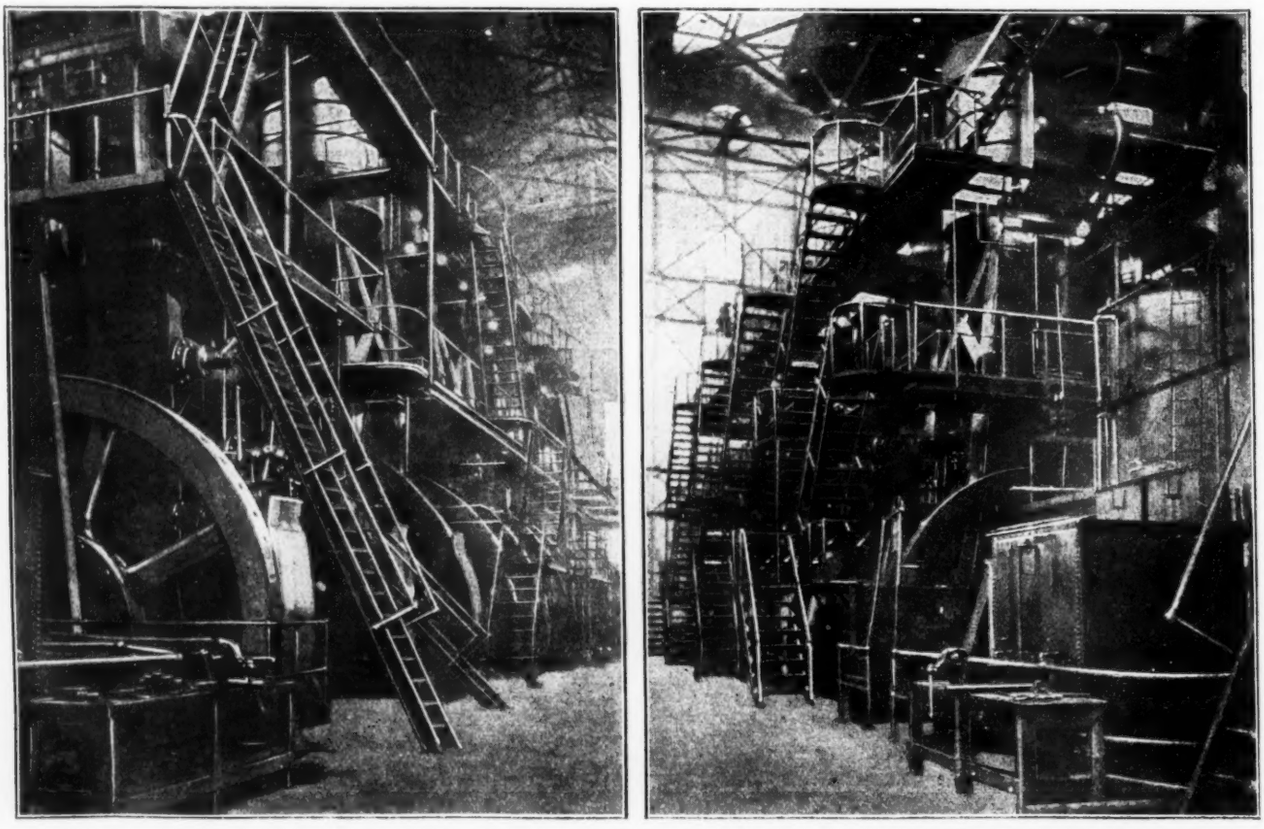


FIG. 4. STEEPLE TYPE OF BLOWING ENGINES AT THE REPUBLIC IRON AND STEEL COMPANY'S PLANT

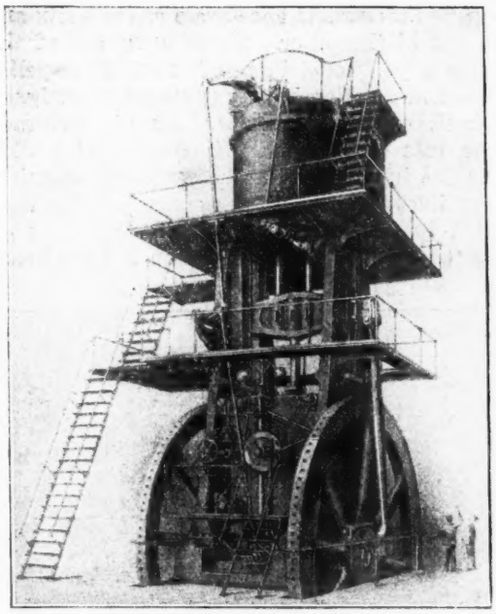


FIG. 5. STANDARD LONG CROSSHEAD BLOWING ENGINE

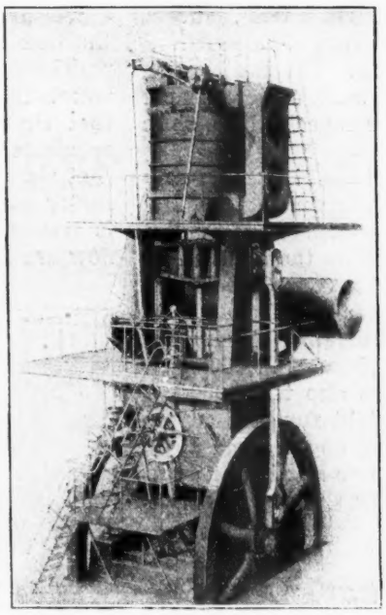


FIG. 6. A LOW-PRESSURE VERTICAL BLOWING ENGINE

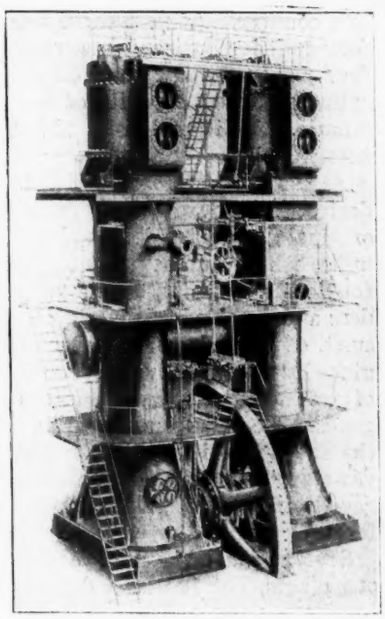


FIG. 7. STEEPLE COMPOUND BLOWING ENGINE

pressure unit can run with either low-pressure machine. All these blowing engines operate with a steam pressure of 150 lb. condensing, as does the cross-compound blowing engine shown in Fig. 7. This unit has a 46-in. high-pressure and a 88-in. low-pressure cylinder and two 79-in. air cylinders with a common stroke of 60 in. At 50 r.p.m. this machine has a capacity of 30,000 cu.ft. of free air with a maximum air pressure of 30 lb. The main bearings are 23 in. in diameter and 36 in. long, the crankpins are 14 x 12 in. and the crosshead pins are 12 x 12 in. The flywheel weighs 100,000 lb., or 50 tons, and is 24 ft. in diameter.

There is also a horizontal-compound blowing engine that supplies air to the bessemer converters. It has 46 and 88 x 60-in. steam cylinders and two 76 x 60-in. air cylinders. This unit has a capacity of 30,000 cu.ft. of free air per minute at 50 r.p.m., against an air pressure of 30 lb. The main bearings are 24 in. in diameter and 42 in. long. The crosshead pins are 12 x 12 in. and the crankpins are 14 x 12 in. The flywheel is 24 ft. diameter and weighs 100,000 lb. or 50 tons. Fig. 8 shows an installation of three Mesta steam cross-compound blowing engines at the plant of the McKinney Steel Co., Cleveland, Ohio.

The design of the blast-furnace plant generally decides the question as to whether blowing engines should be steam or gas driven. The steam-driven units predominate, but a large number of gas engines and units have been installed and in general seem to have given satisfactory results. In some blast-furnace plants it is better to consume all the furnace gas under steam boilers that feed steam engines or turbines. When the blast furnace is operated with a steel mill, a gas engine driven blower is said to pay for itself whenever the coal cost is over $2 per ton. There are, however, so many elements that enter into the question that no engineer would care to make a definite statement as to the superiority of a gas engine over a steam-driven blowing engine without knowing all about the conditions under which they are to operate.

In Fig. 9 are shown five Mesta gas-blowing engines at the Lackawanna Steel Co., Buffalo, N. Y. This company, I was told, was the first in the United States to use blast-furnace gas in gas engines on a large scale. The plant at that time consisted of sixteen 2,000-hp. blowing engines and eight 1,000-hp. generating engines. All these units were of the twin two-cylinder two-cycle horizontal type.

The Gary plant of the Indiana Steel Co. probably has the largest installation of blast-furnace gas engines in

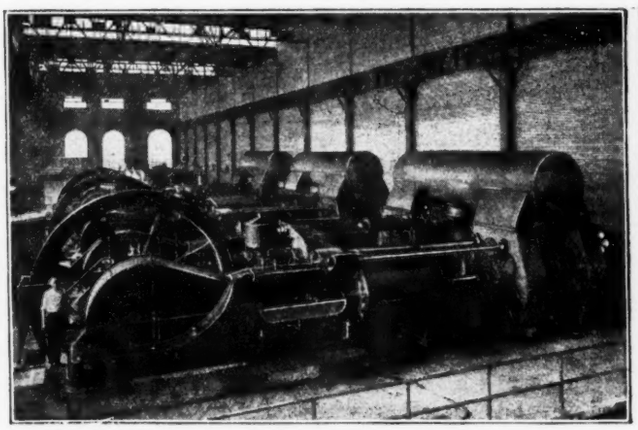


FIG. 8. MESTA CROSS-COMPOUND BLOWING ENGINES

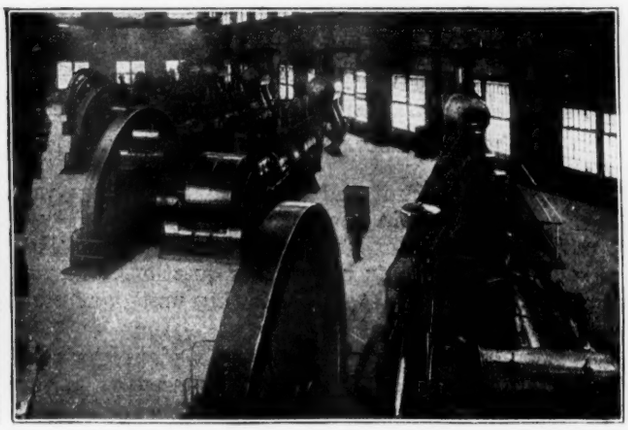


FIG. 9. MESTA GAS-BLOWING ENGINES

this country. At first there were sixteen twin, tandem, four-cylinder horizontal four-cycle types. Each of these four power cylinders was 42 x 54 in. The two blowing cylinders have a capacity of 30,000 cu.ft. of free air per minute. Additional units of larger capacity have since been installed.

At the Sparrows Point, Md., plant the air compressors derive their power largely from gas-driven engines. The original gas-engine driven plant consisted of five tandem units, which number was increased by the addition of fourteen new units, each having 47 x 85 x 60-in. cylinders and capable of delivering between 22,000 and 27,000 cu.ft. of free air per minute. The original blowing engines have a capacity of between 20,000 and 25,000 cu.ft. of free air per minute. There are also ten 4,000-kw. gas-electric twin-tandem units. Eight furnaces supply the fuel for driving sixteen blowing engines and eight gas-electric units, the remainder, three blowing and two gas-electric units, being provided as spares to provide for emergencies.

Several turbo-blowers were found operating at various plants, but it was a difficult matter to photograph some of them.

At the Mark plant, Indiana, of the Steel and Tube Company of America, there are two Ingersoll-Rand turbo-blowers, each having a capacity of 50,000 cu.ft. of free air per minute, working against an air pressure of 13 lb., Fig. 10. This air is delivered to blast furnaces. Each unit is of 3,000 hp. capacity at 2,500 r.p.m. The turbines are of the uniflow type, and the blowers are designed with five stages.

Blowing of the blast furnaces should be accomplished with a steady air blast, and for that reason, among others, there are those who are in favor of centrifugal compressors, because the blast from such a machine will be a steady blow without pulsations.

Although it is claimed by some that engine-driven compressors discharge air in puffs which correspond to

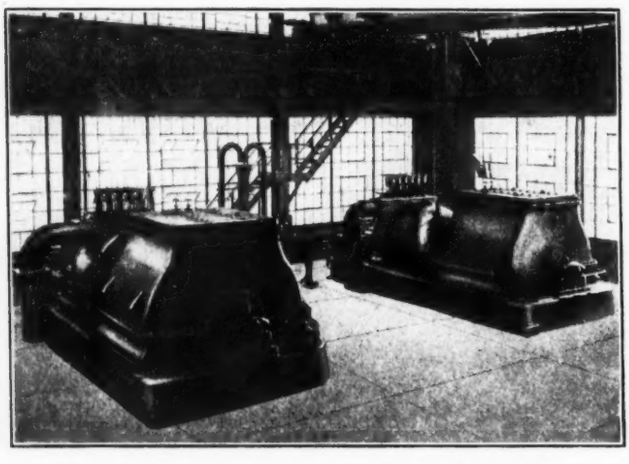


FIG. 10. INGERSOLL-RAND TURBO-BLOWERS

the stroke of the unit and the blast is therefore variable, others maintain that the pulsations are almost eliminated because of the large volume of the blast main and stoves. As in many other questions, there are those who favor both types of blowing units, and much may be said in favor of both types.

At the Republic Iron & Steel Co.'s plant there are two General Electric centrifugal blowers that are directly connected to steam turbine. These units have a capacity of 43,500 cu.ft. of free air per minute with a pressure of 22 lb. Fig. 11 shows one of the units and the turbine end of the other. These units are of the multiple-stage type, consisting of several impeller wheels that run in a casing having passages so designed that the wheels operate in series. An air governor regulates the rate of blowing. It consists of a disk that rides on the ingoing air in the center of a conical fitting on the inlet pipe. Any movement of this disk is transmitted to the valve gear. Differing rates of flow are secured by moving a weight on a scale beam

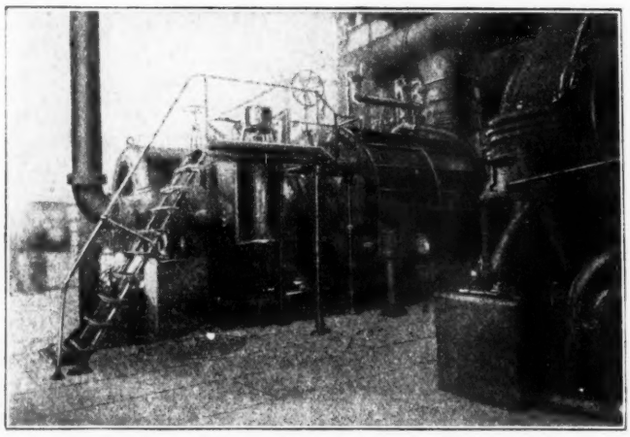


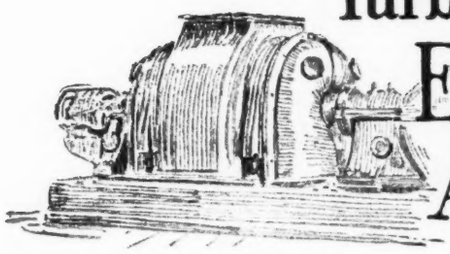
FIG. 11. GENERAL ELECTRIC TURBINE-DRIVEN BLOWERS

that is graduated in cubic feet of free air per minute. In action the operation of the air governor is about as follows:

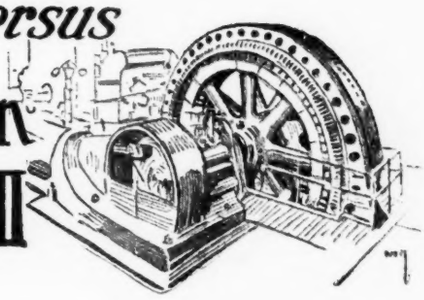
With the turbo-blower running at a low rate of speed, such as would be the case when tapping the blast furnace the force of air current passing through the cone part of the disk will be insufficient to support the disk and the unbalanced weight of the governor beam, and the disk will, therefore, fall against the air current, and in doing so operate a series of valves successively admitting steam to the turbo-blower and increasing its speed. This increases the air pressure in the discharged end about as the square of the speed and produces such a pressure as to overcome the resistance of the blast main, stove and furnaces and establish the desired rate of air flow. It then comes to rest at some point in its housing and the proper number of steam admission valves are opened and the speed of the turbo-blower is what is necessary to produce and maintain the rate of air flow for which the weight on the governor arm has been set, irrespective of the pressure against which the blower has to work.

(The next article will deal with some of the up-to-date power stations, including reciprocating and turbine units, both high and mixed pressure types, found at the rolling mills.)

To avoid the use of decimals in expressing specific gravity, the Baumé system is used in the oil trade. The Baumé scale is purely arbitrary, the point marked 10 corresponding to a specific gravity of 1.0, and the remainder of the scale being graduated in degrees up to 60. A scale having this range can be used for oils having specific gravities from 0.737 to 1.0. It should be noted that an increase in the Baumé reading corresponds to a decrease in the actual specific gravity of the oil; in other words, the heavier the oil the smaller is the reading on the Baumé scale.



Turbine-Driven *versus* Engine-Driven Alternators—III



By S. H. Mortensen*

Quantity of air required, velocity through ducts, layout of ventilating system, temperature limits and means of measuring coil temperatures.

IN PREVIOUS articles the construction and operation of engine-type and turbo-alternators have been compared. Following out this comparison, there is little to be said regarding ventilation of the engine-driven machine, as the open construction makes unnecessary any unusual provisions. Proper ventilation of the turbo-alternator, however, requires careful consideration not only in the design of the machine, but also in its installation and operation. Although the individual losses in the turbo-alternator, with the exception of windage and friction, are lower than in a correspondingly rated engine-type alternator, the radiating surface is so small that it is totally inadequate to dissipate the heat caused by these losses without developing disastrously high temperatures.

In the design the problem of ventilation is solved by inclosing the machine and blowing air through a multiplicity of ducts in the stator and core to the parts where the heat is generated. By adopting the inclosed construction, the noise inherent to high-speed operation is materially reduced. There has to be a sufficient number of air ducts in the turbo-alternator to permit a volume of air great enough to conduct away the heat without the air velocity exceeding 7,000 ft. per minute. The amount of air required to keep a machine within a given temperature rise depends upon the iron and copper losses and also upon the windage loss in the machine itself. The friction loss is not to be included, as it occurs outside the machine proper in the generator bearings.

With the specific heat of air taken as 0.237, one cubic foot of air can absorb energy corresponding to 26.7 ft.-lb. with a temperature rise of 1 deg. C. Hence, one kilowatt will heat 1,650 cu.ft. of air per minute, 1 deg. C., or provided it were possible to heat the air uniformly, one kilowatt loss would increase the temperature of 165 cu.ft. of air per minute 10 deg. C. It is, however, impossible to pass the air through the machine in such a way that it will be uniformly heated, and it is necessary to provide a much larger volume of air than is indicated by the theoretical calculations. In practice the actual amount supplied is approximately 100 cu.ft. of air per minute per kilowatt loss in the machine. If, as an example, a machine has 50 kw. loss, it will require for proper ventilation 5,000 cu.ft. of air per minute. In general, a turbo-generator will require from 4 to 5 cu.ft. of air per minute per rated kilovolt-ampere for its ventilation.

Several methods have been devised for guiding this large volume of ventilating air through the machine parts without causing undue friction and heating. One such method is shown in Fig. 1. The arrows indicate the flow of the air through one of the several ventilating ducts in the stator. Part of the air is blown through the air gap, cooling the rotor and inner stator surfaces. The main portion, however, passes over and between the exposed parts of the stator coils, over the rear surface of the core punchings and through a number of short paths in the core iron to the main exhaust chamber in the yoke. With this ventilating arrangement the temperature of the turbo-alternator can be kept within the safe operating limits of either class "A" or class "B" insulation (see article II in the Mar. 16 issue), depending upon the size, rating and voltage of the machine.

In laying out the power station and foundation for large turbo-generators, provision should be made for air channels of ample size for guiding the cooling air to and from the machine. The channels should be reasonably short and without abrupt bends or turns, and have sufficient cross-section to keep the air velocity below 1,500 ft. per minute.

After the turbo-alternator is in operation as much attention should be given to its ventilation as to its oiling system. As the bearings require an adequate amount of cool, clean oil, so the generator requires an adequate amount of cool, clean air. If the oiling is neglected, the bearings will overheat and suffer destruction. If

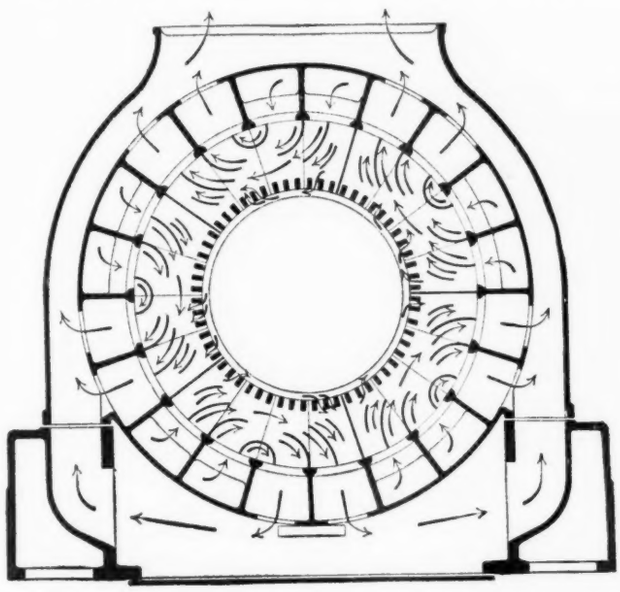


FIG. 1. SECTION THROUGH TURBO-ALTERNATOR SHOWING PATH OF VENTILATING AIR

*Electrical Engineer, Allis-Chalmers Manufacturing Company.

the ventilation of the generator is restricted or throttled down, the generator will overheat and its coil insulation will be damaged.

In the installations where clean air is not available, air filters or air washers should be provided. The air is filtered by drawing it through screens covered with light flannel or cheesecloth. The area of the filter should be such that the velocity of the air through it does not exceed 10 ft. per minute. If the velocity is that low, the filter will not clog up with dirt as readily, and there will be comparatively little resistance to the flow of the ventilating air. Filters of this type require constant care and cleaning and should not be used where the air contains much dirt. In that case the air washer should be installed. Here the dirt is washed out of the air by means of a water spray and at the same time the temperature of the air is brought to within a few degrees of the temperature of the water in the washer. It may be assumed that at least during

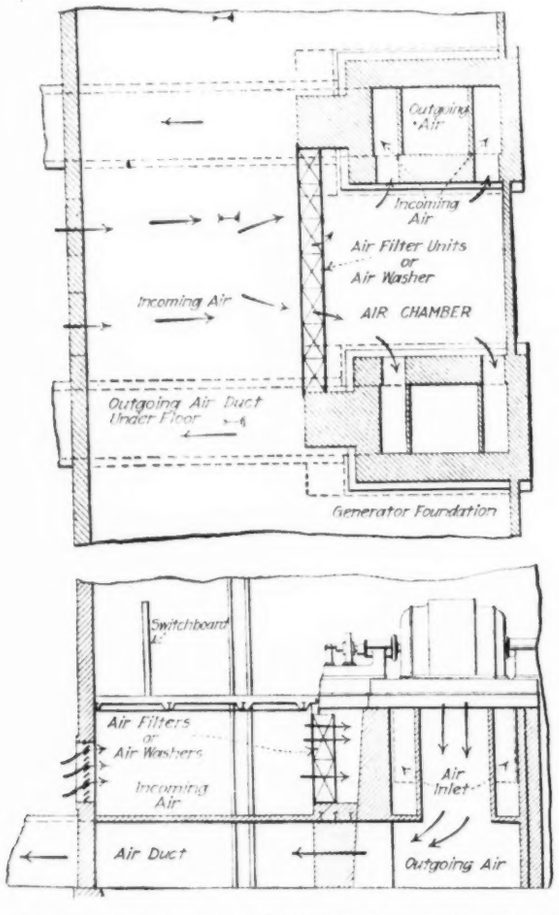


FIG. 2. VENTILATING LAYOUT FOR TWO TURBO-ALTERNATORS

summer months the water in the washer is considerably cooler than the air, and in that case its temperature will be lowered and the rating of the machine can be increased correspondingly.

In Fig. 2 is shown a ventilating layout of two turbo-alternators. Forced ventilation may be supplied by fans which are part of the machine itself or by means of auxiliary fans. The air is cleaned and guided through the machines and discharged from the bottom of the stator into an air channel and may be utilized either for heating purposes, forced draft under the boilers or for similar purposes.

In turbo-generators the coil insulation used is either class "A" or class "B" or a combination of both. In large machines it is difficult to ventilate all parts equally well, and the temperatures of certain spots in the core are likely to be much higher than the average machine temperature would indicate. These spots, frequently referred to as "hot spots," are located in the middle of the stator core, either in the core iron or in the stator coils buried in the slots. To enable the coil to success-

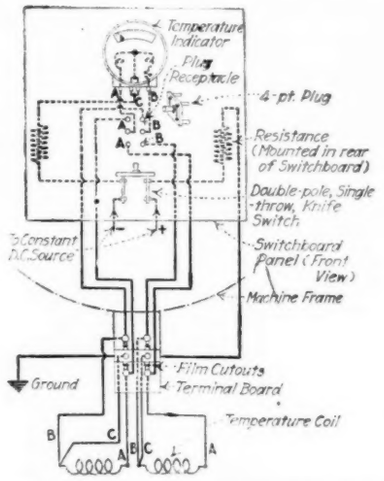


FIG. 3. WIRING DIAGRAM FOR TEMPERATURE INDICATOR

fully withstand hot-spot temperatures, it is common practice on large machines to insulate the slot part of the stator coil with class "B" insulation. This is not required on the free ends of the stator coils, as they get into direct contact with the cooling air. It is furthermore desirable to use class "A" insulation on the coil ends, as it is more flexible than the mica insulation and is less liable to suffer damage when the coils are placed in the stator slots.

How the Temperature of an Inclosed Machine Is Determined

Special arrangements are required to determine the temperature of an inclosed machine. The thermometer method that is used on engine-type alternators can only be applied to the stator-coil ends or the surface of the iron and cannot reach the interior part of the machine where the maximum temperatures are developed. For this purpose either resistance coils or thermocouples are built into the machine and located in the parts of the winding that supposedly develop the maximum operating temperature.

In applying the "resistance-coil method," coils wound noninductive, from fine copper or nickel wire and having a fixed resistance at a fixed temperature (generally 10 or 100 ohms at 20 deg. C.), are placed in the stator winding. With the increase in the temperature of the machine the resistance of the embedded coil also increases, and by connecting it to a properly calibrated instrument, the temperature of the portion surrounding the coil can be read directly. Several types of instruments are available, both indicating and curve drawing. The curve-drawing instrument gives a permanent record of the operating temperature during any time the machine is in operation.

For a double-layer winding it is customary to locate the resistance coils between the two coil halves in the middle of the stator core. Even with this location it is assumed that the resistance coil does not indicate the maximum temperature of the machine. To obtain this

temperature the standardization rules of the American Institute of Electrical Engineers specify a correction of 5 deg. C., or 9 deg. F., to be added to the temperature indicated by the resistance coil. For class "B" insulation with a temperature limit of 125 deg. C. (257 deg. F.) the maximum observable temperature is 120 deg. C. (248 deg. F.) and the maximum temperature rise based on 40 deg. C. (104 deg. F.) ventilating air is 80 deg. C., or 144 deg. F. Under these conditions the maximum temperature of the class "A" insulated coil ends must not exceed 105 deg. C. (221 deg. F.) in the hottest spot, or a 50 deg. C. (90 deg. F.) rise as determined by the thermometer.

As the resistance coils only indicate the stator temperatures, in determining the safe load of a turbo-generator it is necessary also to consider the rotor temperature. It will be found frequently that the rotor is the limiting factor, especially where low power-factor loads are involved. As it is impractical to place resistance coils in the rotor winding, its temperature is determined by the increase in resistance method. If the safe operating temperature of the mica-insulated rotor is placed at 150 deg. C. (302 deg. F.) and the usual correction of 15 deg. C. (27 deg. F.) is allowed, the maximum observable temperature is limited to 135 deg. C. (275 deg. F.), or 95 deg. C. (171 deg. F.) rise over the air at 40 deg. C., or 104 deg. F.

Fig. 3 is a wiring diagram for a temperature-indicating instrument. The leads from the resistance coils are brought outside the machine to a terminal block where connections are made to the instrument. As long as the resistance and material of the connecting wires are alike, their length has no influence on the accuracy of the meter, which for that reason can be installed in any convenient location. The indicating instrument requires a source of constant-voltage direct current for its operation.

As the temperature throughout the machine varies and as a consequence the resistance coils indicate different temperatures, it is customary to use the coil that indicates the maximum temperature for determining the safe load on the machine. By keeping a record of the temperatures corresponding to different loads and comparing them occasionally, it is possible to determine when the machine needs cleaning, as the presence of dirt in the ventilating ducts will cause the operating temperature to increase.

Rules for Autogenous Welding

The following rules, adopted by the Committee on Standards for Locomotives and Cars, United States Railway Administration, for the purpose of preventing the abuse of autogenous welding for purposes for which it is not well adapted, have been sent to the regional directors by Frank McManamy, assistant director of the Division of Operation, with instructions to direct all roads to observe the rules in the construction or repair of locomotive boilers, so that any failures which may have been caused or contributed to by unrestricted or improper use of autogenous welding may be prevented:

1. Autogenous welding will not be permitted on any part of a locomotive boiler that is wholly in tension under working conditions, this to include arch or water bar tubes.

2. Stay-bolt or crown stayheads must not be built up or welded to the sheet.

3. Holes larger than 1½ in. in diameter, when entirely closed by autogenous welding, must have the welding properly stayed.

4. In new construction welded seams in crown sheets will not be used where full-sized sheets are obtainable. This is not intended to prevent welding the crown sheet to other firebox sheets. Side sheet seams shall be not less than 12 in. below the highest point of the crown.

5. Only operators known to be competent will be assigned to firebox welding.

6. Where autogenous welding is done, the parts to be welded must be thoroughly cleaned and kept clean during the progress of the work.

7. When repairing fireboxes, a number of small adjacent patches will not be applied, but the defective part of the sheet will be cut out and repaired with one patch.

8. The autogenous welding of defective main air reservoir is not permitted.

9. Welding rods must conform to the specifications issued by the Inspection and Test Section of the United States Railroad Administration for the various kinds of work for which they are prescribed, which specifications will be issued later.

Miners' Wages Are Fair, Says Doctor Garfield

Dr. Garfield, former Fuel Administrator, in an article written for *Farm and Home*, declares the compromise that ended the coal strike to be "unsound in principle and a menace to our institutions." Dr. Garfield goes on to say:

"The wages now paid to mine workers are sufficient. The opportunity that should be the mine workers' cannot be secured merely by an increase in wages."

In proof Dr. Garfield cites the average of $950 per annum earned by the lowest paid miners working 180 days in the year, while for 200 days' work the average miner in the bituminous fields of Pennsylvania, Ohio, Indiana and Illinois earned $1,660 in 1918 and $1,300 last year. This, says the article, is "more by a considerable sum than the average net receipts of the farmer and many others who may or may not work 300 days or more in the year."

"The public ought not to be asked to pay more for coal," emphasizes the ex-Fuel Administrator. "It is impossible to increase the wage of the mine workers without inciting the workers in every other industry, including, of course, agriculture, to demand an increase in wages. This would send the cost of living upward in a vicious spiral, which will in the end prove hurtful to the workingman. The purchasing power of the dollar and not the number of dollars received is the important factor.

"The public is the chief sufferer when capital and labor engaged in the production of commodities necessary to the support of life fall a-fighting," continued Dr. Garfield. "In these cases certainly the interest of the public is vital and, therefore, paramount. We may admit the right to strike on the part of labor, and the right of capital to boycott, but in each case the right of the public to live is paramount and will be asserted.

"We now are called upon to contemplate an arrangement with a group opposing the government which, however it terminates, is unsound in principle and a menace to our institutions."

To guard against affairs reaching the strike stage, Dr. Garfield in the same article urges that a permanent fuel administration be established so that it can serve as a consultive and advisory tribunal and head off difficulties before they come to a head.

Reorganization of the Massachusetts Boiler Inspection Department and Board of Boiler Rules

In the reorganization of State Commissions by the Massachusetts Legislature the Boiler Inspection Department became a part of the Department of Public Safety administered by a Commissioner of Public Safety and comprising three divisions—that of State Police under his own immediate charge, that of Inspections under a Chief of Inspections, and that of Fire Prevention under a State Fire Marshall. The Division of Inspections includes the functions of the old Boiler Inspection Department and of the Building Inspection Department, both of which were under the old District Police. The Board of Boiler Rules remains as previously constituted with the exception that the Chief of Inspections is chairman. The personnel is as follows:

Commissioner of Public Safety, Col. Alfred F. Foote, Holyoke; Chief of Inspections, John H. Plunkett, formerly chief of the District Police.

BOARD OF BOILER RULES

John H. Plunkett, Chief of Inspections and (ex-officio) Chairman of the Board.

Frederick A. Wallace, M. E., Chief Engineer, Pacific Mills, Lawrence, representing boiler-using interests.

Henry H. Lynch, President of the Hodge Boiler Works, East Boston, representing the boiler-manufacturing interests.

John A. Collins, Secretary of the Mutual Boiler Insurance Co., of Boston, representing boiler-insurance interests.

John Moles, Chief Engineer, American Writing Paper Co., Holyoke, representing operating engineers.

New Copes Regulator

Since the first introduction of the Copes mechanical feed-water regulator changes have been made in the details of construction, the principle of feeding remaining the same. Recently, the design of the central valve has been altered. Fig. 1 shows the new valve, in which

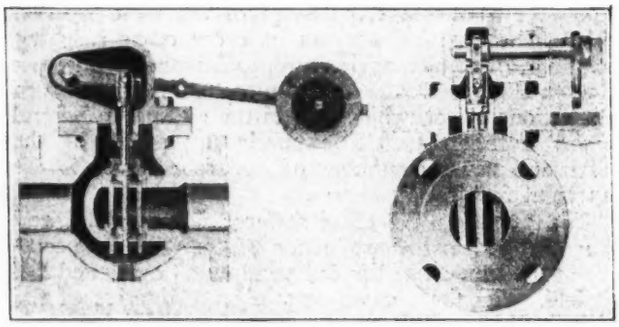


FIG. 1. SHOWING CONSTRUCTION OF THE VALVE

the reciprocating stuffing-boxes have been abandoned, a horizontal shaft introduced, which rotates very slightly, performing the same function as the old reciprocating rod. This new design is sensitive, and the frictional resistance has been reduced as much as six to sixteen pounds. It is now practically zero because the shaft rotates very slightly and the same part of the shaft is always in the stuffing-box.

The valve is of the balanced piston type. The weight on the valve lever exerts a constant closing force of fifty pounds on the valve piston. A weight is used here rather than a spring because gravity does not vary, whereas springs grow weak with age, corrode, stick, break, etc.

A vertical section through the valve displays the horizontal shaft, the stuffing-box, the linkwork connecting the shaft with the piston valve, etc. The valve cap or bonnet can be unbolted and removed with the fittings attached without removing the valve body from the pipe line.

The assembled Copes regulator, which is manufactured by the Northern Equipment Company, 111 West

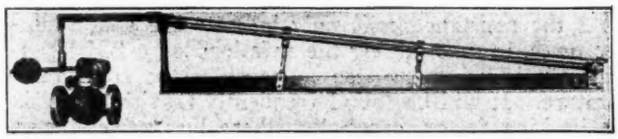


FIG. 2. THE ASSEMBLED REGULATOR

Eleventh St., Erie, Penn., is shown in Fig. 2. It consists principally of a heavy, long diagonal expansion tube known as the thermostat. It is a straight piece of heavy metallic tubing 1¼ in. outside diameter. The top of the thermostat is connected with the steam space of the boiler and the bottom with the water space. Hence there is a water level in the thermostat that corresponds to the water level in the boiler, and it is this water level that determines the rate of feed. The tube lengthens and shortens with a drop and a rise of water level. The lengthening and shortening are caused by change in temperature of the tube as the water rises and falls. This expansion or contraction is amplified by means of the linkwork shown in Fig. 2, and through the linkwork operates the control valve.

Why Our Oil Supply Is Limited

Assuming a population of 108,000,000, the consumption per person in the United States during 1918 was 3.4 bbl. of petroleum, says *Petroleum Magazine*. The oil that has been produced since 1859 amounts to about forty-five barrels per person, and the oil yet underground, according to the most careful estimate, amounts to about sixty-seven barrels per person.

If the population of the United States remained unchanged and the rate of consumption did not change, the oil available would last about twenty years. But the population is continually increasing and the demands for petroleum are multiplying, so that in less than twenty years the known domestic underground fields will be exhausted if the statistics are even approximately correct. Oil shales are not considered in this connection as a source of fuel oil.

This conclusion does not mean that fuel oil users will be unable to obtain supplies, for the data apply only to the sources of petroleum within the United States. There are vast fields in Mexico and Russia, from which oil may be obtained, but of course at increased cost because of the transportation expense.

A report issued by the Department of Commerce, Bureau of Foreign and Domestic Commerce, Washington, of exports of refrigerating machinery from the United States to various countries shows Japan well in the lead, with Canada, Cuba, Argentina and Brazil following. A report on exports of pumps and pumping machinery shows Cuba leading, with imports costing $126,892.

EDITORIALS

Funds for Investigating Water-Power Resources

THE shortage of power on the Pacific Coast, particularly in California, has intensified interest in water-power development. The universal increasing cost of coal, difficulties with the enormous labor forces engaged in its production and the burden placed upon transportation facilities in distributing it are bringing about a broader and more universal realization of the importance of water power. In many localities water power cannot compete with fuel power now, but the disparity between the two sources of energy is gradually disappearing. Much thought is being directed toward the advantage to be gained through a combined usage supplemented by interconnecting large areas with superpower transmission lines.

One reason why water-power development has progressed somewhat slowly is that we are not well enough acquainted with its possibilities and limitations. Hydraulic development must be adapted to many physical features, of which a sound knowledge of water supply is extremely vital. The only safe means of predicting future regimen of water courses is by considering performance in the past. All other physical features except water supply may be ascertained within a relatively short time. Reliable records of flow for a number of years must be available for proper design and practical plans for operation. In other words, the need for stream-flow records must be anticipated far in advance of development. Many hydraulic projects have failed on account of an altogether too meager knowledge of water supply. Others based on short time records, comparisons with records of near-by streams, and climatological data, have levied an enormous toll upon the public, which pays either directly or indirectly for inefficient service resulting from unexpected annual or seasonal variation in flow.

The question arises, What agency should collect the mass of information necessary for comprehensive development? The Water Resources Branch of the United States Geological Survey has made a systematic investigation of water resources and related problems for a number of years. It has become the well-recognized medium for collecting stream-flow data throughout the United States, in Hawaii and in Alaska. An efficient organization with well-formulated methods has been evolved with a surprisingly small expenditure. During the ten fiscal years ending June 30, 1920, the fund made available by Congress for this activity has averaged only $155,000 a year, $150,000 each year except 1918 and 1920, when $175,000 was appropriated. Numerous single water-power developments, promoted and constructed on the basis of data collected by the United States Geological Survey, have cost many times the entire amount appropriated during the ten years. Naturally, the demand for stream-flow records has increased rapidly. Coöperation, tendered to meet this demand by states and interested parties, has increased so greatly that for the fiscal year 1920, the Federal appropriation represents only twenty-nine per cent of the cost of the work. A limit is being reached in the amount of coöperation that can be absorbed. In fact, many interests desirous of obtaining stream-flow records and willing to pay for them, in so far as possible, have been refused assistance because the Federal personnel can not handle properly the coöperation now in force. Having absorbed the maximum coöperation possible the United States Geological Survey is confronted with an ever-increasing demand for stream-gaging results to be met with decreased purchasing power of funds appropriated. Obviously, Congress should support the work in such manner that at least fifty per cent of the cost of records would be borne by the Government. This would mean increasing the present appropriation from $175,000 to something over $300,000 per year, and providing increases from year to year depending upon the demand. As a long period of record is desirable for wise development, it would seem proper for the Government to anticipate development far in advance of demand and provide funds accordingly. If this policy were adopted, an appropriation of at least $500,000 would be needed.

The inadequate funds appropriated by Congress for investigating one of our most important future assets can be accounted for only in two ways: either Congress does not pursue a farsighted and constructive policy regarding future advancement, or Congress is wholly lacking in its realization of the benefits to be gained by full utilization of water-power resources

Cooling of Turbo-Alternators

TURBO-ALTERNATORS are in most all cases cooled by passing large volumes of air through and around the machine's cores and windings. This air is made to circulate through the machine either by fans built in the rotor or by a separate blower. The amount of cooling air required per hour by a modern machine attains tremendous proportions, amounting to nearly the weight of the alternator itself. When this cooling air is washed by a water spray about ninety-eight per cent of the dirt in the air will be removed. However, even with so low a percentage of dirt remaining in the air passing through the alternator, considerable material will be deposited in the ventilating ducts and on the end of the windings, and not infrequently oil vapors are carried into the machine. These dirt deposits not only decrease the efficiency of ventilation by reducing the quantity of air and preventing transfer of heat from the core and windings to the air currents, but they also create a real fire hazard. If these deposits become ignited by either electrical or mechanical causes they will soon be fanned into a flame that is liable to seriously injure if not completely destroy the generator windings.

The effects of fires and failures in large turbo alternators have become so serious both in this country and abroad that other methods of ventilation have been given serious consideration. With the very satisfactory

experience of the oil insulated transformer to draw from it is not suprising that considerable attention has been directed to oil as a cooling medium for alternators. Although it is within the possibilities of a practical design to immerse the stator core and windings in oil, it is very doubtful if this would offer a real solution to the problem. In the transformer the windings can be thoroughly insulated and space provided for the circulation of oil between the coils and still keep within the limits of an economical design, but in an alternator the slot insulation is the limiting factor in high-voltage machines. Immersing the windings in oil would not improve the insulation in the slot although it would overcome a number of the objectionable features of air ventilation. However, there are many factors in the application of this scheme that make its possibilities very doubtful.

In a paper presented before the British Institute of Electrical Engineers, January 8, 1920, J. Shepherd suggests a method of cooling alternators by a system of circulating water through the rotor and stator cores. Although this scheme would greatly increase the ability of the machine to dissipate the heat losses it, nevertheless, would be difficult of application and would require a special design such as suggested by Mr. Shepherd. Experiments with an improved system of cooling large alternating-current generators with air, in a system which is completely inclosed, by recirculating the air after being cooled, apparently offer the best solution to the problem. Although this scheme does not possess all the qualities that might be desired, it does prevent dirt from getting into the machine and in case of internal fires possesses advantages in extinguishing them. Furthermore, such a scheme is applicable to standard equipment. When this system of cooling is applied with a balanced-relay method of protection to disconnect the machine from the line and open the field circuit, in case of internal trouble, the causes of a large percentage of the disastrous fires in turbo-alternators will be eliminated, without involving any of the complication inherent in any system of oil or water cooling.

Long Longitudinal Seams on Boilers

THE chief inspector of one of the boiler-insurance companies, reverting to the discussion upon the length of longitudinal seams in boilers which took place in *Power* some months since, remarks that all of those who contributed to the discussion seemed to consider the subject from the point of view of constructional strength. There is much to be said from the operator's, owner's and underwriter's standpoint.

Distress in the girth seam is one of the first indications of trouble in the furnace sheets. A leaky roundabout has often called attention to an accumulation of scale or grease upon a fire sheet which, but for this warning, might have resulted in a serious bulge or bag. The girth seam is also a strengthening ring for the sheet. He had recently been called to see a boiler in the fire sheets of which were two bags, one in front of and one just behind the first girth seam. If this had been one big sheet, the bags would have run together and probably have ruptured, causing a disastrous explosion.

With a long sheet, therefore, bagging is more likely to occur from lack of notice through leakage; when it does occur, it is likely to cover more area and be deeper and more serious than in a smaller sheet; there is less chance of its being possible to work the sheet back into place or to patch it, and if the sheet has to be replaced, it is much less expensive to renew a short course than a long one.

In his opinion the provision that longitudinal joints on horizontal boilers shall not exceed twelve feet in length is therefore a wise one and should hold for this class of boiler whether the longitudinal seam is lapped or butt-strapped. In the shells of internally fired boilers and in the drums of water-tube boilers, where the sheets are not in the fire, these considerations do not apply.

A New Plan for Co-operation Between Industry and the Colleges

REALIZING that technical schools are not serving to a maximum degree the industries to which they owe their existence, the Technology Clubs Associated has proposed a plan for closer coöperation between the agencies for training technical men and the industries in which their training is to be used. The plan is to be perfected and set in operation at a meeting in the Drexel Institute, Philadelphia, on March 25 to 27.

The plan consists of several parts: First, the writing by the representatives of industry of a definite specification of the type of man most needed; second, the writing by the representatives of the colleges of a definite statement of the capacity of the colleges to meet this demand; third, forming a mutual specification from these two and developing permanent means for carrying out the work so as to continue permanently the coöperation thus begun. It is also proposed to publish the results of the meeting in book form as a matter of record.

The execution of this idea should result in increasing the efficiency of the technical schools by showing them just what type of instruction is needed in the industries. It should increase the efficiency of industrial organizations by providing men trained in accordance with industry's needs. It should accomplish these results in a minimum of time because it is dependent on and provides for direct contact between the teachers and the users of trained men.

Notwithstanding the comparative immunity of European countries from boiler explosions, they do have one sometimes. A dispatch from Benrath, Rhenish Prussia, states that fifty lives were lost when a large boiler exploded in the Rhenish Westphalian Electricity Works. Following this dispatch, news comes in of the explosion of a boiler in an electrical station at Mayence, France. Ninety workmen were buried in the ruins, and fourteen bodies had been taken from the débris when the dispatch to the *Petit Parisien* was sent. Probably owing to a relaxation of the usually strict and effective governmental supervision of European boilers and to the increasing activity of our own industrial commissions and other safety organizations, the United States will not have so large a lead in industrial disasters this year as usual.

As was generally expected, Senator Norris' amendment to the Water-Power Bill, providing $25,000,000 for the development by the Government of the Great Falls power project on the Potomac, above Washington, was eliminated at the first meeting of the Senate and House conferees on the measure.

CORRESPONDENCE

Knoxville Industrial Co-operative Plan

In the winter of 1918, just following the wholesale inspection of all power plants by the Fuel Administration, a body of men in Knoxville undertook to improve power-plant conditions in the Southern States, and especially in Knoxville. This group of men was the Knoxville Chapter of the National Association of Stationary Engineers. Throughout the Knoxville district a large number of plants needed repairs, not for the sake of efficiency, but to make them safe places to work in. There were plants in existence that did not dare ask any high-grade boiler insurance company to put their test pumps on their boilers for fear of a rupture.

After considerable discussion the engineers decided that the quickest method to bring about effective results was to introduce a license law for the City of Knoxville and to incorporate in that law sufficient protection for the operating engineer.

The engineers appointed a committee for drafting this ordinance, and called in the writer in a consulting capacity to help. What was considered a fair ordinance was finally evolved and placed before the City Commission. The municipal law of Knoxville requires that all ordinances shall pass three readings before they become laws. This ordinance passed two of the necessary readings, but at this juncture the stationary engineers believed it would be more fair to call in the manufacturers, in an open meeting of their organization, to ask them their opinion of the bill.

Like many other requests coming from the employees, this invitation was ignored except by four or five of the manufacturers of the city, who seemed to realize the importance of the bill. These few men attended the open meeting, then called, on the following day, a meeting of all interested manufacturers into a secret conference. This was where they made one of their errors, as they failed to show a spirit of coöperation with the employees and aroused antagonism. A secret meeting of this type, following what was a fair invitation by the engineers for a get-together conference, is not good business management. Conditions became chaotic. The manufacturers decided to fight the ordinance.

A counter proposal was offered at this point by the University of Tennessee. This proposal, presented to the manufacturers, signed by them, and on the following day accepted by the engineers, put up to all parties a common basis of coöperation. By it the manufacturers promised:

1. That they would appoint a committee of five to coöperate with a committee of five from the National Association of Stationary Engineers, to put into effect the principles set forth in the preamble of the constitution of the National Association of Stationary Engineers.
2. They agreed to financially provide for five courses on steam engineering and allied subjects, the students to pay for textbooks.
3. They agreed to finance an advertising campaign to put these classes in operation.
4. To subscribe the funds to publish a four-page monthly *Power Plant Efficiency Bulletin*, to be placed in the hands of every fireman and engineer in the city.
5. They agreed to hold a "power-plant efficiency banquet" at some date during the year, at which time both engineer and manufacturer would feast together. The engineers were to arrange the banquet, and the expense was to be divided among all. At this banquet the National Association of Stationary Engineers were to prepare a comparative table showing which ten plants in Knoxville were, in their judgment, the most efficient. Further, a similar announcement was to be made of the engineer and fireman, who were, in the opinion of the National Association of Stationary Engineers, the most deserving of the distinction and recognition of being placed first in their profession in the city.

Today this entire program has been completed for a cycle of one year. To maintain a fair censorship, the writer, at the request of both parties, accepted the editorship of the *Power Plant Efficiency Bulletin*, which is referred to in the foregoing agreement. He was assisted by a committee of four from the National Association of Stationary Engineers, and at no time during the year did he find it necessary to cut out material that was undesirable or unprintable. Furthermore, he has received a large number of articles from these practicing engineers that were worthy of a place in any high-class engineering journal. It has had a very healthful influence upon all of the stationary engineers and firemen of the city, for not only have they been able to express themselves in writing for the general public, but they have monthly received the *Bulletin*, with articles written by men whom they knew. Naturally, the busy engineer is more ready to read material coming from the pen of a friend than that coming from a stranger.

That the whole program has been a great success was demonstrated most emphatically by the success of the banquet recently held. The program was ar-

ranged by a committee from the National Association of Stationary Engineers, and shop talk was almost entirely eliminated from the program. When they gathered at the St. James Hotel in Knoxville, both sides were represented by a full quota. The program was a live one, with a real live toastmaster, who was neither an engineer nor a manufacturer, to keep things moving. As an impromptu part of the program he made every manufacturer and engineer get up on his feet and tell where he was from, where he lived, and what his position might be. No one could go away without saying that he had not made a speech at the banquet.

The cost to each manufacturer for the entire year, for carrying out this agreement was approximately $5, and I believe, as a fair estimate, we can say that in those plants where the spirit of the plan has been felt at all, the investment of this $5 by the manufacturer has brought in a net return of several hundred per cent of healthy coöperation on the part of the engineers.

There is in the ordinary power plant no one man who is in a position to spread either the seed of contentment or discontent to a greater measure than the engineer. The manufacturing power-plant engineer usually must assume the responsibilities of a master mechanic and of a general repair man. He is known to practically all the force, and discusses from day to day the matters of the factory that are nearest the heart of the employees. It is far easier for him to feel the pulse of the employees than it is for any member of the management. He often must assume the rôle of a personal relations manager for the factory in which he is located.

We are confident that the rôle assumed by the university has made it a force for healthy coöperation, and we find both engineers and manufacturers equally pleased with the results that have been obtained.

Knoxville, Tenn. W. R. WOOLRICH.

Freezing of Brine Puzzle

In the Jan. 6 issue, page 35, under the heading, "Freezing of Brine Puzzle," C. A. Goodwin draws some conclusions from his experience with a frozen brine cooler that appear to be false.

Unfortunately, he does not give data relating to the temperature of the brine entering and leaving the cooler, the range, or decrease in temperature, between the inlet and outlet brine, suction pressure under which the cooler is operated and such other data as would assist the readers in determining the cause of his trouble. However, it is evident that he makes a practice of keeping his brine solution too weak, for with the double-pipe brine cooler the margin of safety between the lowest working temperature of the brine and its freezing point must be great enough to allow some leeway, as such coolers will freeze up quickly if the conditions are not as they should be.

Mr. Goodwin concludes that the freeze-up, in the case under discussion, was directly due to the fact that about two coils of the submerged cooler were above the brine level and that the freezing occurred in these two exposed sections. This is incorrect, as there never exists such a wide difference of temperature as he assumes in such a short length of brine travel; that is, from the top of the submerged part of the cooler to the two upper sections of the cooler that had been uncovered by the brine.

As a matter of fact, in a properly operated cooler of this design a range of usually 5½ to 6 deg. between the inlet and outlet of the cooler is considered good practice, and if his assumption were correct, he would get more than a 6-deg. range in about three coils instead of the entire cooler.

I assume that his cooler is connected up on the counter-current principle—that is, the ammonia and brine travel in opposite directions and the cold brine leaving the cooler comes in contact, so to speak, with the coldest ammonia—in which case there should not be, as he supposes, a wide difference of temperature or heat head between the evaporating ammonia and the brine to be cooled.

Under normal operation this heat head or temperature difference should not exceed 10 deg., and it may run as low as 5 to 8 deg. Also, if the brine enters at the top of the cooler and the ammonia enters at the bottom, the coldest brine would be found in the submerged section near the outlet connection and not in the exposed section as he supposes.

If Mr. Goodwin will check up his thermometers for accuracy, place a pressure gage on the brine pump, keep the brine strength at its proper value and deliver sufficient brine to the cooler to maintain the proper range for a given tonnage or load condition, he should not have any trouble with the freeze-ups; also when adding more water to the tank to raise the brine level, do not dump fresh water in the tank while the cooler is in operation and add the calcium afterward, because if this is done it is almost certain to result in a frozen cooler. C. T. BAKER.

Atlanta, Ga.

Packing Valve Stems Under Pressure

On page 835 of the Dec. 16-23-30, 1919, issue of *Power*, Gustav Swenson writes that Mr. Jackson must be a wizzard if he can pack a globe valve with the pressure coming above the valve disk. It can easily be done, however, by taking a piece of band iron ⅜ in. thick, ¾ in. wide and 4 ft. long and making a clamp of a size to get around the packing nut.

To pack the valve, first open it wide, so as to check the flow of escaping steam as much as possible from around the valve stem. Then remove the valve wheel and the packing nut. A piece of burlap may be thrown over the valve to baffle the steam.

The packing rings should be a loose fit around the valve stem and a tight fit inside the packing nut, enough new ring being used to fill the nut about three-fourths full. The clamp can then be tightened to the stuffing-nut for screwing it in place on the valve. The strap is then removed, and the operation need not take more than two minutes if everything has been made ready.

Mr. Swenson also says that I seemingly favor connecting globe valves with the pressure under the disk. On the contrary, I am strongly in favor of having the pressure under the disk.

Regarding clogging of valves, neither a globe valve, elbow nor pipe that is attached to a water column will close up, if it is watched and attended to as it should be. If the water is very dirty, clean out the bottom connections often. JAMES E. NOBLE.

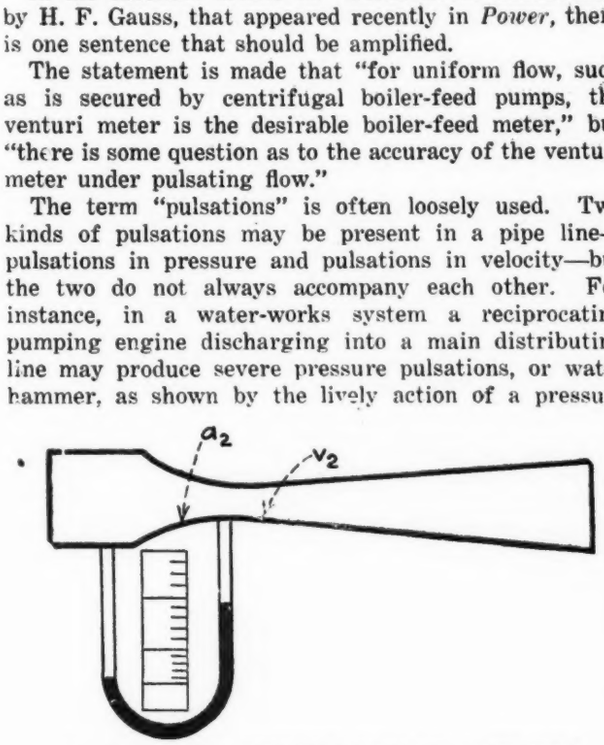
Portsmouth, Ont., Canada.

Boiler-Room Essentials

In the excellent article on "Boiler-Room Essentials," by H. F. Gauss, that appeared recently in *Power*, there is one sentence that should be amplified.

The statement is made that "for uniform flow, such as is secured by centrifugal boiler-feed pumps, the venturi meter is the desirable boiler-feed meter," but "there is some question as to the accuracy of the venturi meter under pulsating flow."

The term "pulsations" is often loosely used. Two kinds of pulsations may be present in a pipe line—pulsations in pressure and pulsations in velocity—but the two do not always accompany each other. For instance, in a water-works system a reciprocating pumping engine discharging into a main distributing line may produce severe pressure pulsations, or water hammer, as shown by the lively action of a pressure



DIAGRAMMATIC PRESENTATION OF A MERCURY MANOMETER

gage, and this effect may be noticed miles distant, but a venturi meter in the main would reveal a very steady flow. The reason for this is that the friction of the long discharge line and distributing branches absorb and smooth out the peaks in the flow line.

In a boiler plant pulsations in pressure are usually accompanied by pulsations in flow, although the venturi-meter tube can often be placed beyond a filter or economizer, which tends to straighten out the flow line. A long experience with the measurement of boiler feed by venturi meters proves that single-plunger pumps, almost without exception, give error-producing pulsating flows when the water is pumped directly through the venturi-meter tube or any other meter of the so-called velocity or inferential type. Not all duplex pumps cause severe enough pulsations to be detrimental, and triplex pumps in good condition can be used without taking any precaution to dampen the pulsations. When two or more duplex feed pumps are in service, the character of the flow is suitable for correct meter registration.

To determine accurately the extent of error produced by a pulsating flow through a venturi-meter tube, the latter should be connected in the usual manner to a mercury manometer, as illustrated diagrammatically by the accompanying sketch. Let:

R = Rate of flow;
C = Meter coefficient;
g = Acceleration of gravity;
a_2 = Throat area;
v_2 = Throat velocity;
h = Differential pressure in manometer.

$v_2 = C \times \sqrt{2gh}$ $\quad R = a_2 \times v_2 = a_2 \times C \times \sqrt{2gh}$

The scale is graduated in the rate R, which, according to the formula, varies as the square root of the differential pressure.

To take an extreme case of pulsating flow, assume that high and low peaks produce a maximum differential nine times as great as the minimum differential in inches of mercury column.

$$\frac{\textit{Actual maximum rate of flow}}{\textit{Actual minimum rate of flow}} = \sqrt{\frac{9}{1}} = \frac{3}{1}$$

or, actual average rate of flow = 2. But the average mercury differential in the manometer as observed would equal 5 in. Therefore;

$$\frac{\textit{Observed average rate of flow}}{\textit{Actual average rate of flow}} = \sqrt{\frac{5}{2}} = 1.12.$$

or the error resulting from reading the scale opposite the average mercury level is +12 per cent.

Since recording instruments employ a much larger weight of mercury than a manometer, and hence, owing to the inertia of the mercury, cannot follow changes in velocity as rapidly as a manometer, the recording instrument may show even a greater plus error than the manometer. Employment of the latter, however, provides a ready means of determining the extent of the error of the recorder under any condition of operation.

Throttling the small pressure connections between the meter tube and the recording instrument would only aggravate the error. The only practicable method of overcoming the difficulty, as all manufacturers of the velocity type of meter will frankly acknowledge, is to absorb the pulsations in flow before the water enters the meter. If the latter cannot be advantageously located to accomplish this, as outlined, a suitable air chamber should be installed in the main line preceding the meter, designs for which have already appeared in *Power*. It may be set down as a general rule that if the pulsations in velocity are severe enough to affect the accuracy of the venturi-meter readings, the pulsation in pressure is causing destructive water hammer on the pump parts, valves, fittings and gaskets and is in itself sufficient argument for a remedial air chamber.

Providence, R. I. CHARLES G. RICHARDSON.

Use of Bichromate Salts as Boiler Compound

A short time ago a reader of *Power* requested data concerning the use of bichromate as a preventive of corrosion in steam boilers.

This subject has received pretty thorough investigation, and I suggest that reference be made to J. Newton Friend's work entitled "Corrosion of Iron and Steel," as published by Longmans, Green & Co. In the chapter headed "Influence of Solutions of Electrolytes upon Iron," the subject of bichromates and chromates is gone into very thoroughly.

While, under certain conditions, the sodium and potassium bichromates and chromates will produce a protective action of the metal, the amount required per thousand gallons of water evaporated renders its cost prohibitive.

Furthermore, as will be noted from the article in question, much better results can be obtained by the use of the chromate instead of the bichromate, since if the latter is employed in the presence of foreign salts, especially sodium chloride, very little protection is secured on account of the liberation of free acid.

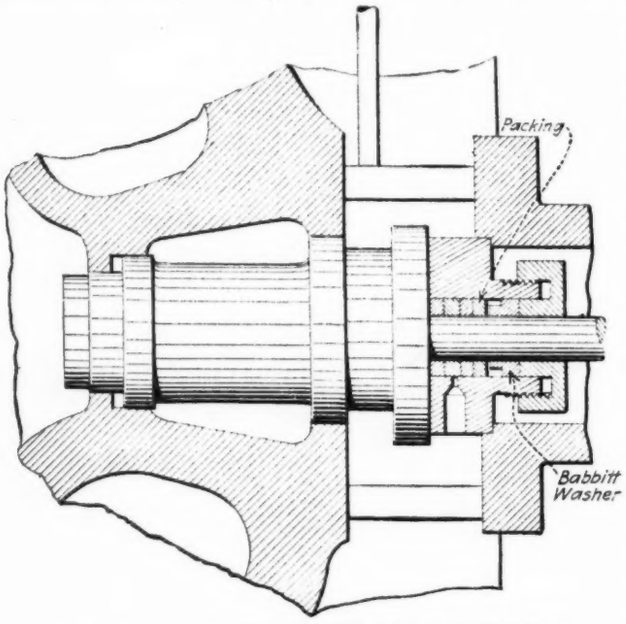
Chicago, Ill. E. L. GROSS.

Trouble with Spray Valve Packing

Having had considerable trouble with spray-valve packing on a semi-Diesel engine with closed tap valve, I am submitting the following:

Because the stuffing-box was not deep enough the shredded metallic packing which was used would work out around the outside of the gland enough to keep it from drawing up and keeping the packing tight on the valve.

To remedy this trouble I cut a piece of babbitt ⅛ in. thick and large enough to cover the opening in the



BABBITT WASHER APPLIED TO STUFFING-BOX

stuffing-box. I then drilled a hole in the center of this the size of the spray-valve and cut the piece down to a little larger than the opening and forced it into the box so as to get a better fit on account of the box being badly scored.

By using this between the gland and the shredded packing there has been no further trouble.

Covington, Ohio. HARRY A. HAPPLE.

Lubricating an Engine Under Varying Load Conditions

I read with unusual interest the letter of Charles J. Mason on page 672 of the Dec. 8 *Power*, treating the question of lubricating an engine under widely varying load conditions. When Mr. Mason says "A fully loaded engine using large volumes of steam per stroke is easy to lubricate as compared with under-loaded engines with an accompanying early cutoff and small steam volumes," he is giving expression to a privately formed conclusion that I have arrived at through the study of a most peculiar behavior of piston-rod packing on an engine now in my charge. This engine is perfect in alignment, adjustment, design and workmanship and is my pride as well as the praise of inspectors and supply men who come to the plant. But while this engine "runs like a song" it can destroy more piston-rod packing than any other engine I ever saw. In my search for a packing that would give satisfaction on this engine I carefully selected and tried out six good standard makes and all failed. These packings would all give good results for a while, then, suddenly, and with less than two minutes' warning, would burn out. Sometimes the packing would run beautifully for a month or more before burning out and then again it might run only one week after being freshly packed. The burning out would take place as follows:

All would be running smooth and well when all of a sudden I would hear the packing start to blow and I would find it smoking. The blowing would increase rapidly and become violent while smoke would come from the rod and box in clouds. Upon examination I would find the rod with what I call "a hump on its back" (horizontal engine). The rod instead of being straight would be raised in its middle a full ⅛ in. and pinching the top sides of the packing rings till they simply burned up. The hotter the top side of the rod became the more it humped up, due to the expansion of that side, and the more it humped up the greater became the friction and heat on that side to hump it up more. A brush and a can of cylinder oil would straighten the rod out again in a few minutes without stopping the engine, but that gland-full of packing was lost. If the packing were soft, it was burned and if it were semi-metallic the metal would be melted out of it.

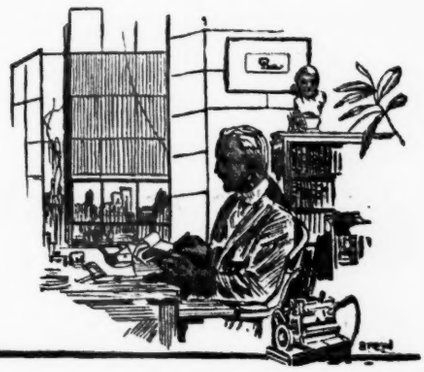
This might happen any time either on an old gland full of packing or on a newer one regardless of make. I came to the conclusion that there must be times when the rod failed to get oil and ran as long as it could on what the packing had absorbed. But the natural tendency of the oil would be to gather in the lower halves of the packing rings, leaving the top halves comparatively dry, and the top side of the rod next to the dry half of the rings would be the first place to gather excess heat from lack of lubrication. As quickly as the rod started to warm and expand along its top side, the bending effect due to unequal expansion would take place and the performance I have described would be gone through with.

I next noticed that this overheating always took place when the load was almost nothing and the steam pressure high. The engine is 15 x 18 in., running 200 r.p.m. directly connected to an a.c. generator and runs on 135 lb. steam pressure. The load averages 150 hp. but varies from 3 to 200 hp. At certain seasons of the year we frequently get a load of 3 hp. (one small motor) for several hours at a time. The friction load is practically nil due to lack of belts and shafting, and at these periods I get a diagram that almost comes back on the compression line.

I am firmly convinced in my own mind that at these periods of short cutoff and small volume of steam the flow past the lubricator nozzle is not sufficient to atomize the oil or carry it along the rod as the rod is drawn into the cylinder. After a lot of study and experimenting I have found an almost perfect cure for the trouble in a combination of two things. First, I arranged an oil cup over the rod so that the drop would fall upon its upper side, and this I keep filled with cylinder oil so that I can turn it on whenever I see the ammeter drop back to almost zero and remain for any length of time. Second, I found a packing that is made of asbestos product and will neither burn or melt. This packing is made to contain annular cavities encircling the rod and will yield to the distorted rod and come back to place when the rod straightens again.

Vancouver, B. C. R. MANLY ORR.

INQUIRIES OF GENERAL INTEREST



Velocity in Pump Suction and Discharge Pipes—What velocities are allowable for water pump suction and discharge pipes? G. L. J.

In order that loss of pressure from pipe friction may not be too great for ordinary lengths of pipe lines, the velocity of water in the suction pipe should not exceed 240 ft. per minute and that in the discharge pipe 300 ft. per minute.

Relative Heat in Water and Steam of Boiler—Does a pound of water in a boiler contain as many heat units as that quantity converted into steam at 100 lb. or any other pressure? R. B.

The water in a boiler is at the same temperature as the steam but before the water can be converted into steam it must receive additional heat, called the latent heat of evaporation. Thus for 100 lb. gage pressure the water and steam are at a temperature of 338 deg. F. and each pound of the water contains 309 B.t.u. above 32 deg. F., but for conversion into steam, each pound of water must, in addition, receive 879.8 B.t.u. which is the latent heat of evaporation at the stated pressure; so that the total heat contained by a pound of the steam is 309 + 879.8 = 1188.8 B.t.u.

Size of Steam Pipe for Engine—What size of steam pipe would be required for an 18 in. x 36 in. engine running 110 r.p.m., assuming the velocity of steam in the pipe is 7,000 ft. per min. W. H.

The piston displacement of the engine would be $(18 \times 18 \times 0.7854) \times 36 \times 2 \times 110 = 2{,}015{,}399$ cu.in. per min. Allowing that the maximum velocity of the steam in the pipe is to be 7,000 ft. or 84,000 inches per minute, when the piston is traveling at its average speed, the required cross-sectional area of the steam pipe would be 2,015,399 ÷ 84,000 = 23.99 sq.in. which corresponds to

$$\sqrt{\frac{23.99}{0.7854}} = 5.5 \text{ in. dia.}$$

The least commercial size of pipe required would be 6 in. inside diameter.

Weight Required at End of Safety Valve Lever—If the area of a lever safety valve is 1 sq.in., distance from valve to fulcrum 2 in., weight of lever 2 lb., distance of its center of gravity to the fulcrum 5 in., weight of the valve and stem ½ lb., and total length of lever 15 in., what weight must be placed on the end of the lever so the valve will blow off for a pressure of 100 lb. per sq.in.? A. B. T.

The lever alone will exert a pressure on the valve of (2 x 5) ÷ 2 = 5 lb., and as the weight of the valve and stem is 0.5 lb. the lever and dead weight of the valve will balance a pressure of 5.5 lb., leaving 100 − 5.55 = 94.5 lb. of pressure to be exerted on the valve by the leverage of the weight placed at the end of the lever. As 1 pound at the end of the lever would exert a pressure on the valve of 1 x 15 ÷ 2 = 7.5 lb., the additional 94.5 lb. pressure required would be balanced by a weight of 94.5 ÷ 7.5 = 12.6 lb. placed on the end of the lever.

Sizing Bushing for Engine Cylinders—We are preparing to rebore and bush a 26 x 42 in. Corliss engine cylinder. The bushing is to be about 1 in. thick and the cylinder will be bored in four steps. How much oversize will it be safe to make the bushing larger than the cylinder diameter to press the bushing in place with a 35-ton jack? W. D. P.

No more than a snug fit is necessary when the bushing and cylinder are at the same temperature and appropriate provision is made for preventing the bushing from turning or slipping endwise in the cylinder. Very good jobs have been made by turning off the outside of the bushing about 0.005 of 1 in. greater in diameter than the diameter of the cylinder bore when both are at the same temperature and then inserting the bushing with the cylinder warmed up and the bushing cold. By that method the pressure required for forcing the bushing into the cylinder will depend upon the force required to spring the bushing to the form of the cylinder in compensation of imperfect boring and turning.

Required M.E.P. for Generating Stated Kw.—What would be the m.e.p. in the cylinder of a 10 x 10 in. engine running 300 r.p.m. direct connected to a generator for developing 35 kw.? R. C.

For estimating the required m.e.p. it is necessary to take account of the efficiency of the engine and generator. One kw. is development of work at the rate of 44,240 ft.-lb. per min. and, assuming the mechanical efficiency of the engine to be 85 per cent and the efficiency of the generator as 90 per cent, the work required by the steam acting on the engine piston would be

$$\frac{44{,}240 \times 35 \text{ kw.}}{0.85 \times 0.90} = 2{,}024{,}052 \text{ ft.-lb. per min.}$$

One pound m.e.p. in a 10 x 10 in. engine running 300 r.p.m. would develop

$$1 \times (10 \times 10 \times 0.7854) \times \frac{10}{12} \times 2 \times 300 = 39{,}270 \text{ ft.-lb. per min.}$$

and therefore the generation of 35 kw. would require 2,024,052 ÷ 39,270 = 51.54 lb. m.e.p.

Effective Pull of Belt—What is meant by "belt pull" and how is it computed? Is belt pull the same as belt stress? What would be the belt pull in driving a machine that requires 20 hp. where the belt speed is 2,325 ft. per minute? W. N. J.

The term "belt pull" is commonly employed to signify the effective pull or difference in tensions of the tight side and slack side of a belt when transmitting power. The actual pull or tension that tends to draw the belt apart is the tensile stress and the intensity of that stress usually is expressed in pounds per square inch of cross sectional area of the belt.

For transmission of 20 hp., or 33,000 × 20 = 660,000 ft.-lb. per minute, and for a belt speed of 2,325 ft. per min. the effective pull would be 660,000 ÷ 2,325 = 283.9 lb. For transmission of any given power with a given speed of belt, the maximum tensile stress, or actual pull coming on the tight side of the belt, depends on the required effective pull, the tension under which the belt was put on pulleys and elasticity of the belt material.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Engineering as Prosperity Insurance*

By GEORGE OTIS SMITH†

INDUSTRY is a reaction into which raw material and energy enter: it is the function of engineering to use both material and energy in the smallest quantities possible, in other words, to make what is used do the most work. To appreciate the rate at which we increase our annual drafts upon Mother Earth's treasury, a glance at the records for the two chief metals and the two mineral fuels is perhaps enough. Within the last half century the country's output of coal has increased more than 20-fold, iron more than 23-fold, and copper 68-fold, while the flow of petroleum has increased not less than 700-fold. This growth of the mining industry within the life of most of us must open our eyes to the real issue of safeguarding our sources of supply.

Although the 99 per cent or so of coal left unmined is a figure that might seem to justify an optimism as to coal that is not warranted as to oil, we may need to think less of the million of millions of tons of coal which we are told lie awaiting our needs over the length and breadth of our land and to ask for more details as to where this coal is and how much of it remains in the older mining districts.

Before you indulge in mental arithmetic in figuring out the life of our coal resources, you must set down the broad fact that the best and most accessible coal is mined first. From this premise follows the practical prophecy that with the passing of time in our rapid industrial expansion we may expect for the coal of our future output decreasing quality and increasing cost. It is this aspect of our tomorrow that forces the discussion of the best use of America's coal.

The reason for our interest in the past and future of coal is that coal will count for more and more as the controlling factor in America's industrial future. Even now we can take our country's record of the highest per capita coal consumption in the world as the gratifying test of our industrial capacity.

Lessons of the Armistice Period

The lessons of the armistice period have increased our appreciation of the factors that insure prosperity. Raw materials and tools are what the war-stricken peoples of Europe are asking for; with these idleness and hunger can be converted into industrial and physical health. Coal and flour are two excellent antidotes for bolshevistic infection.

Human energy was something that the ancients spent with little regard for present or future happiness. The great monuments of the past—the engineering wonders of the world—commemorated slave labor. Today we regard man-power as something to be conserved, not only because we as practical business men set a higher value upon humanity than even the philosophers of old, but also because we have learned that in much that we try to do, man-power is the limiting factor.

To lighten the load of labor is the real purpose in planning for power. In the evolution of industry animal-generated power was first brought to the aid of man, then wind and running water were harnessed, next fuels through the agency of steam made possible the modern industrial system, and now electricity has been made a servant of man that promises to lift the burden of toil so that human energy can be put to the highest tasks.

The official estimates of the potential water power in the United States when figured on an 80 per cent efficiency indicate in round numbers a minimum of 30 million horsepower and a maximum of 60 million horsepower. The water power now utilized, however, is less than one-third of the minimum potential power, or taking a world view of the water-power situation, we find our country standing third in potential power resources, with about 7 per cent of the world supply, but first in rank, as determined by developed power, with 45 per cent of the world's total. Canada, France and Norway stand next in order as to power developed, but the total of all three is only half the water we use.

These are the basic facts that suggest what the future can hold for us. Unfortunately, there remains a fact of geographic distribution that affects future utilization: as pointed out recently by W. B. Heroy, 70 per cent of the available water power is west of the Mississippi, whereas 70 per cent of the water power now installed is east of the Mississippi. With the largest power market and the largest power supply so separated, fuel power must continue to carry its part of the load.

Super-Power Plan for Eastern Industrial Region

The super-power plan that is now being advocated for the great industrial region of the East seems a direct answer to the appeal for the best use of America's coal. In its broad outlines this plan, for which a Federal investigation is being asked of Congress, is the linking up of high-power, high-economy generating stations with a super-power transmission line—a veritable stream of power from which will flow the current wherever it is needed for transportation, industry or home use. You engineers do not need to be told by me the possibilities of saving through higher load factor, low coal consumption and greater certainty of continuous service. How the engineering details of so great a plan are to be worked out is a story for future telling; but we can confidently expect that this interstate system, so essential to the whole nation in helping us to meet international competition effectively, will be thoroughly democratic in spirit and will be so planned as best to serve the greatest number of citizens.

In setting up a practical ideal for a power system, the two words "public service" are enough. Service to the public is the power plant's reason for being, and the quality of that service should measure the corporation's standing with the customer and indeed in the community and in the Nation. I fear lest for political effect too much stress is often laid on price; of course both economist and engineer must give full attention to the question of cost, as well as the possible profit in the business, but another element in service is perhaps even more important, and that is reliability. I notice that Robert Treat in a recent technical paper puts foremost among the aims of the electrical engineer who is planning large electrical layout reliability of supply and continuity of service: The flow of energy must be uninterrupted.

The power company, then, deals in service. A recent article in one of the engineering journals in describing a great interstate power system classified the causes of the interruptions of service on its lines so far as they could be determined. Lightning and sleet and high winds, which are beyond the control of either company or customers, together caused 33 per cent of the breakdowns, but failure of the customers' apparatus and carelessness in the customers' operation caused 35 per cent of the interruption in service, while the corresponding figure for company failure and carelessness was less than 10 per cent.

Quality of Service Dependent on Consumers

At the Natural Gas Conference in Washington last week it was likewise pointed out that in that type of public utility also the quality of the service rendered the public depends largely upon the consumers themselves Methods of use within the house not only control the service there, but also affect the service rendered to other consumers. The public-utility engineer can profitably devote some time to the education of his customers.

No type of citizen is better fitted to tackle the civic problems of today than the engineer. The large questions before the people are economic questions, and engineering is mainly science applied to life in an economic way; the engineer in his experience as well as in his training has studied problems in economics, whether his textbook bore that title or not or whether his design or his contract was so labeled or not. The constructive issues that are before the American people this year and that promise to remain before our legislative bodies for several years are all in some degree engineering issues, and in a large degree they present on a national scale

*Abstract from an address delivered before Engineers' Club of Philadelphia, Penn., January 20, 1920.

†Director, United States Geological Survey, Washington, D. C.

problems closely akin to those of everyday work that you engineers have in hand on a unit scale.

The transportation problem now before Congress, with Mar. 1 as the date of delivery for the legislative remedy; the many questions relating to the production and distribution of the commodities that are essential to life and comfort; the working out of the equities of the partnership between labor and capital and the public—these are all practical economic issues to the consideration of which the engineer can bring an analytical mind and a large store of facts.

These public questions are more or less interlocking; our coal problem is hitched up with the railroad problem, and both are related to the super-power plan, while the power program in turn contributes to the labor question, and the underlying ideal of prosperity distribution is but another name for profit sharing which involves accounting in terms of equities. Some of the outstanding elements in these national issues may be stated, however, even if a logical analysis of each question is not made.

How the Various Interests Are Tied Together

The coal industry furnishes perhaps the best example of how the operators, the mine workers and the consumers are all tied together in actual interest. The curve of weekly coal production tells the story of highly irregular operation, and idle plants and idle men are expensive taxes upon the community and the Nation.

For three months this last spring the coal mines of the country were operated, on an average, for only about 24 hours a week. From coast to coast the reason for lost time was "no market"—something beyond the control of either operator or mine worker. Here, then, is the greatest branch of our mining industry vitally affected by a widespread malady, the remedy for which lies with the public alone. Laws cannot make coal mines operate when there is no outlet for their product, but education of the consuming public may accomplish much in bettering the conditions of demand, and we as consumers will do well to remember that the price we pay for coal must in the long run be enough to pay for the idle days of both mines and miners, as well as for the days they work. The public interest lies in a longer working year, not in a shorter day or week. Largely on account of the irregular market demand for coal, our mines since the armistice was signed have actually averaged only 30 hours of working time a week; throughout the year there have been too many mines and too many miners waiting for work. A 30-hour week is the ailment, not the cure.

In normal years the seasonal fluctuations in the demand for soft coal cause a slump in mine output during the spring and a peak of forced production in the fall and early winter. Compared with the average for the whole year, the monthly rates of output will commonly range from 81 or 82 per cent in March and April to 115 or higher in October and November. The mine operator is dependent upon a too irregular market.

Comparison of Coal Consumption of Typical Power Companies

As a suggestive comparison I have taken the coal consumption of six large typical power companies—companies having an aggregate installed capacity of nearly 700,000 kw.—which furnish electric current to a trunk-line railroad and several street-railway systems, as well as general lighting and power service in metropolitan districts. The daily average coal consumption of these companies by months during ten months of last year furnishes a curve that shows a seasonal fluctuation similar to that of mine output, but the departures from the base line representing the average for the whole period are much smaller—92 per cent is the spring low, and 110 per cent is the winter peak. Applied to the general curves of soft-coal production for several years, this consumption curve of six companies shows that for three-fourths of the time such power companies could exert a helpful influence on the market, even if they bought their supply from day to day. The storage of anything like a reasonable tonnage of coal at such plants would still further smooth out the curve and help to put the coal industry on a better basis. The influence of such consumers is well worthy of consideration, for these six companies alone use nearly one-half of one per cent of the soft coal mined. It is also doubtless true that by connecting up such power units into a single system the improved load factor would tend to smooth out the curve of coal consumption, and the pooled purchase of coal would further help abate the seasonal demand which is today the greatest evil in the bituminous-coal industry.

The leaders in industry today are calculating the vision of a new type of prosperity tomorrow which must mean profit sharing on a thoroughgoing scale so that all concerned are to receive in proportion as they have served. The goal of wisely directed industry is the prosperous community of happy homes, and engineers must direct such industry.

Cooperation of Accountants Necessary

Yet the engineer must have the full coöperation of the accountant if the returns from industry are to be fairly divided. A true diagnosis of the financial condition of any industry involves bookkeeping that states the real economic symptoms. In mining, as in all other productive business, production costs should express all the facts, but I am convinced that we have not yet reached that stage in our accounting methods. Does not the cost of a pound of copper just as truly include its share of the interest due on the bonds and the dividend due on the capital stock actually paid in—that is, wages paid to capital—as it includes the wages paid to the mine worker or to the man in the smelter? Of course neither payroll should be padded. Do not regard the definition of profit as a simply academic question for college professors to discuss; it is more a matter of fundamental concern to the men who are trying to build up the industry.

In the first place, such terms as "net earnings," "profit," "net income," "surplus," or "balance to surplus account," which appear on your financial sheets, are too optimistic in tone when the operating costs do not include any charge on account of the investment. The inference is too easily drawn that this surplus is available for profit sharing between labor and capital.

In the second place, I fear lest accounting which does not count all the costs may lead us to fail to appreciate the results of American engineering. Our engineers, backed up by red-blooded capitalists, are constantly lowering labor costs by increasing the investment in improved mine equipment. This means replacing the hardest part of labor with machinery—it means working dollars instead of men—so that your cost keeping conceals the true state of things if you pay labor out of so-called "costs" and capital out of so-called "profits."

Those are some of the reasons why we need to unite in urging the engineers of the country to take a larger share in citizenship; indeed, these are compelling reasons for engineers to assume more of leadership in public opinion. The engineer is a forward-looking worker, but to get in fullest measure the pull of inspiration in our work, perhaps we need to hark back as well as look ahead. Prosperity of the right kind is all we can ask and all that we need to work for. If the door of large opportunity is to open wide for all our people, the key to unlock that door is good engineering.

It is estimated, says the *Engineer* of London, that at the present time the Irish bogs contain between 3,500,000,000 and 4,000,000,000 tons of anhydrous peat, or 5,000,000,000 tons of air-dried peat. At present about 6,000,000 tons of peat are burned as fuel in Ireland per annum, and over 4,500,000 tons of coal are imported. If this coal were replaced by peat fuel at the rate of two tons of air-dried peat to one ton of coal, the total consumption of peat in Ireland would be about 15,000,000 tons per annum, and the peat deposits would be sufficient to satisfy the fuel and power requirements of the country at the present rate of consumption for more than 300 years.

In an article on the development of the power of the Niagara Falls in the *Bulletin* of the Ontario Hydro-electric Commission, it is shown how as long ago as 1812 Augustus Porter and Peter Emslie began the construction of a power canal 100 ft. wide. The canal was ultimately completed with a width of 35 ft. and a depth of 8 ft. By 1885 the full capacity of this canal, 10,000 hp., was being utilized.

Fuel-Oil Bibliography

The following bibliography leaves much to be desired, yet it will go far to meet the demands of engineers interested in it from the power-plant standpoint:

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McIntosh	Physical Properties	32	Jan. 6, see also Jan. 27, p. 146.
McIntosh	Government Specifications for Purchase of Storage and Piping	54	Jan. 13
	Oil Burners	105	Jan. 20
	Furnace Design	139	Jan. 27
	Operating Troubles	158	Feb. 3
		195	Feb. 10

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W. G. Greenlees	Burning Fuel Oil Under Boilers	815	June 9
E. H. Peabody	Developments in Fuel-Oil Burning	205	Feb. 11
E. H. Peabody	Developments in Fuel-Oil Burning	244	Feb. 18
H. O. McCarthy	Oil-Flow Problem — Flow from Tank	503	April 8
B. F. Hartley	Heating Fuel Oil in Home-made Heater	60	Jan. 14
Capt. C. W. Dyson	Oil Fuel for Destroyers and Battleships	145	Feb. 4

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W. B. Perkins	Purchasers Test of Crude Oil—Centrifugal	259	Aug. 19
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Halloway	Oil-Burner Regulator	391	Mar. 20
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McHugh	Burner Regulation	229	Feb. 12
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Bromley	Operating Cost Oil-Burning, Tamarack Mills	548	Apr. 16
	Best Auxiliary Burner for Oil or Tar with Coal	261	Feb. 19
Strott	Calculating Contents of Oil Tanks (Formula)	482	Apr. 2
Ward	Calculating Contents of Oil Tanks (Table)	159	July 30

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	Ray Oil Burner	167	July 30
	Correct Color of Flame	961	Dec. 31
	Correct Color of Flame	685	Nov. 5
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	Preventing Waste of Fuel Oil	636	Oct. 29
	Connecting Pipe to Tank	541	Apr. 8 (?)

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	Powell Oil-Burner Valve	55	July 11
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Bromley	Fuel Oil in Jenks Spinning Co.	852	Dec. 19
	Fire Underwriters' Rules for Storage	74	July 11
	Draft Gages on Oil-Burning Boilers	147	Feb. 1
	CO_2 Available with Fuel Oil	543	Apr. 18
Perry Barker	Chart of Coal and Oil Costs	765	May 30
	Ventilated Front Column Stirling Boiler Using Oil	630	May 2
	Relative Heating Valves of Fuels (table)	790	June 6
Kent	Fuels for Boilers	450	Mar. 28

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	Spacing of Burners in Boiler Formerly Used for Coal	361	Sept. 3
	Oil Burning with Various Boiler Settings	181	Feb. 6
	Effect of Temperature on Sp.Gr. of Crude Oil (Chart)	400	Mar. 19
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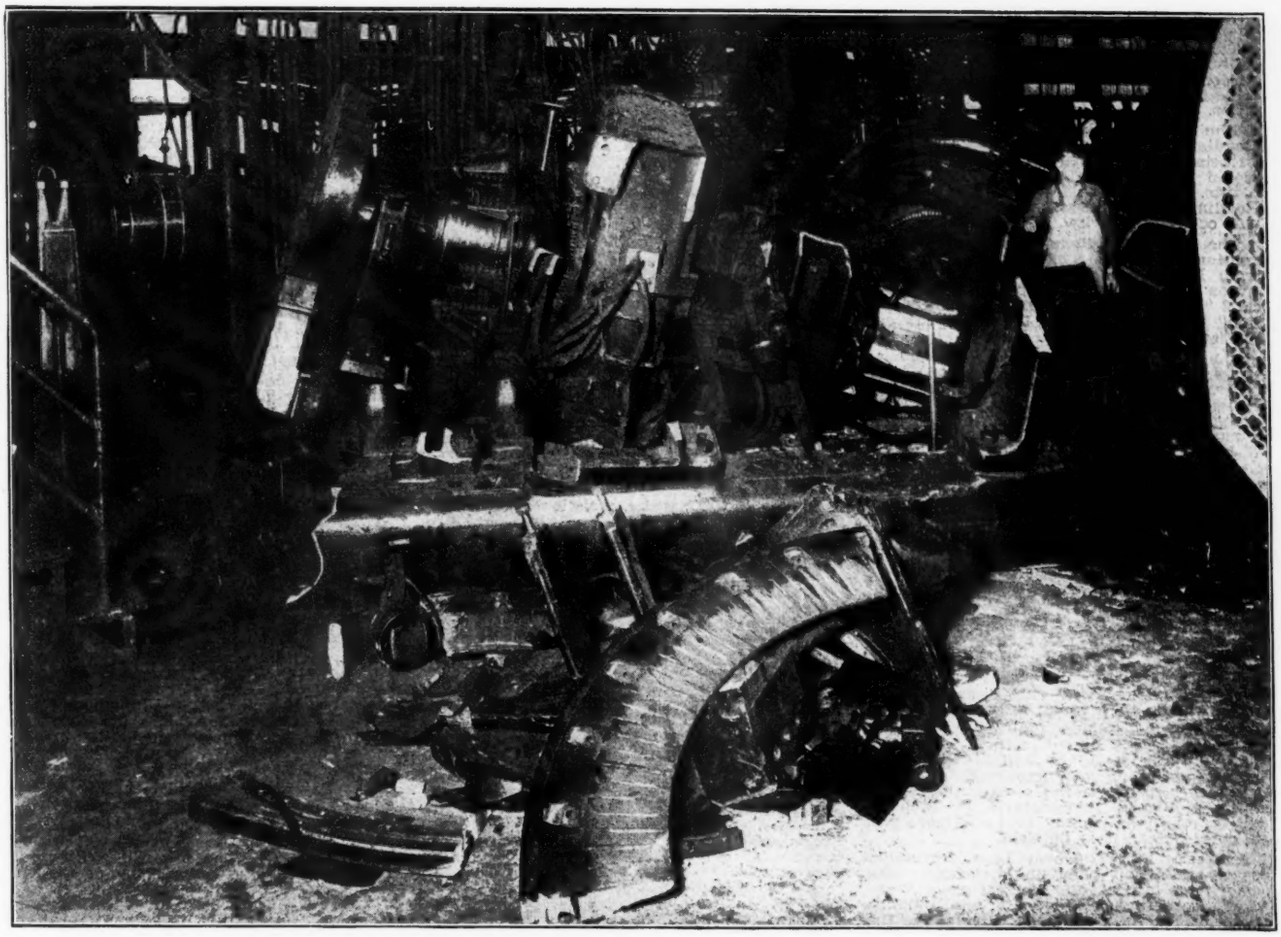

WRECK OF LARGE MOTOR-GENERATOR SET IN THE TOLEDO RAILWAY AND LIGHT CO.'S PLANT, FEB. 21, 1920

This set consisted of two direct-current generators, directly driven by an induction motor. The motor was literally torn to pieces. As can be seen, the generator to the right was torn from the foundation, breaking the bedplate between the motor and the generator. The field frame of the left-hand generator was broken from the bedplate and turned through 90 deg., and has also broken the bedplate where the outboard bearing pedestal is fastened. Apparently, the direct-current generators were motorized and ran away. An investigation is being made, and it is expected that the results will be available for publication in an early issue.

Personals

Col. W. A. Dibblee is now associated with the Western Appraisal Co. and the National Industrial Engineering Co., of Cincinnati, Ohio. He will act as field manager.

Calvert Townley, assistant to the president of the Westinghouse Electric and Manufacturing Co., was reëlected vice president of the United Engineering Society at a recent meeting.

F. P. Brounstead, formerly manager for the Perolin Co. for the State of Ohio, has been appointed assistant manager of the Lubricating Department of the Moore Oil Refining Co., Cincinnati, Ohio.

C. B. Leach, who, for the past two years, has been representing *Power*, a McGraw-Hill Co. publication, in the Philadelphia territory, has taken charge of the Chicago territory, succeeding A. H. Maujer, who has resigned.

D. George McMillan has resigned as superintendent of power with the Singer Manufacturing Co., Elizabeth, N. J., and is now with the Williams Printing Co., of New York City, in the capacity of maintenance engineer.

Engineering Affairs

The Connecticut State Branch of the A. S. M. E. will hold a meeting at the Seaside Club, Bridgeport, March 29.

The A. S. M. E., St. Louis Section, will hold a joint meeting with the Associated Engineering Societies of St. Louis in the Hotel Statler on April 7. F. O. Pahmeyer, engineer for the Heine Safety Boiler Co., will be the speaker.

The A. S. M. E., Buffalo Section, will hold a meeting at the Ellicott Club, Ellicott Square Building, April 6. Harrison P. Eddy, consulting engineer for the City of Buffalo, in connection with sewage-disposal work, will address the meeting.

The South Dakota Electric Association at a recent meeting planned to merge the Minnesota and North Dakota Electric Associations with the South Dakota organization. The new society will be known as the North Central Electric Association.

The Hartford Branch, A. S. M. E. held a meeting at the City Club, Central Row, Monday, March 15. George A. Orrok, delivered an interesting address on Power Production, which was followed by discussion in which members and guests joined.

The American Engineering Standards Committee, after almost three years of investigation by the engineering fraternity, has adopted a revised constitution of very wide scope which allows the direct or indirect participation of anyone interested in Standardization. The new constitution has been ratified by the A. S. C. E., the A. I. M. & M. E., the A. S. M. E., the A. I. E. E., and the A. S T M, and the three Government departments of Commerce, Navy and War

Miscellaneous News

The Alabama Power Co., Montgomery, Ala., is planning to purchase the Gadsden, Attalla & Alabama City Electric Light and Street Car properties.

The Arkansas Light and Power Co. has completed negotiations for the purchase of the power plant at Picon, Ark The deal involves $235,000.00.

The Federation of Mexican Chambers of Commerce has decided to open as soon as possible an International Exposition in Mexico City.

The Chamber of Commerce of the United States will hold its eighth annual meeting at Atlantic City, April 27-29. The subject of the meeting will be "Increased Production."

The Lehigh Navigation Electric Co., Hazleton, Pa., recently appropriated $3,000,000 to increase the electric and boiler capacity of the Hauto plant from 8,000 to 16,000 horsepower.

Permits for the Use of Water for power-development purposes in northern California involving expenditures of more than $11,000,000 have been filed with the State Water Commission.

The Manufacturers Club, of Minneapolis, Minn., has organized a Superintendents' and foremen's section. An employment managers' section and a steel'treaters' section have also recently been organized.

Health Commissioner Robinson, of Chicago, is inaugurating a drive on the smoke nuisance in the Windy City. A number of plants have been closed down until the cause of the trouble can be eliminated.

The Public Service Company of Northern Illinois at its recent annual meeting decided owing to the greatly increased demands for electrical energy in the northern zone, to construct a transformer station at North Chicago. Construction is under way.

The Federal Trade Commission has been given full authority to arrange for the development of useful inventions of departmental employees in order that the public, the industries and the Government departments may get the benefit of them.

A Gigantic Steam-Electric Generating Plant at Milwaukee, Mich., will be constructed by the Consumers Power Co. Five million dollars is the estimated cost of the project, which will aid in supplying light and power to Saginaw and surrounding cities.

The Metropolitan Edison Power Co., of Reading, Pa., and the Pennsylvania Utilities Co., of Easton, Pa., have completed plans for the connection of the two plants. A line will be constructed from Reading to Easton and then to Dover that will convey 7,000 kw. of electricity.

The Seventh National Foreign Trade Convention will be held in San Francisco, Cal., from May 12-15, inclusive, under the auspices of the National Foreign Trade Council. "The Effect of Being a Creditor Nation" will be the main theme of the convention.

The Hartford Electric Light Co., has arranged to purchase the Connecticut Power Co., which has been operating a large hydro-electric power plant on the Housatonic River and western Connecticut. Negotiations are being completed through Stone & Webster, of Boston.

The Bureau of Mines, Department of the Interior, in a series of investigations, recently completed, show that taking gasoline from natural gas does not detract from the heat-giving qualities of the gas. It is estimated that several hundred million gallons of gasoline are added to the country's supply in this manner.

The Metropolitan Edison Co., of Reading, Pa., gave a fine illustration of efficiency, when the West Reading plant was kept running without interruption during a 17-foot flood in the Schuylkill River, which forced its way into the power station and completely submerged pumps and similar equipment on the ground floor.

The Detroit Edison Co. has planned a new plant with an ultimate capacity of 130,000 kw. The plant will be located at Bunce Creek and will supply more power than either the Conners Creek or the Delray plant. An initial expenditure of $2,000,000 will be made, and many millions more will be spent before it is finished.

A Heavy Wind Storm Last November greatly damaged telephone, telegraph and power lines in the State of California. Temporary repairs were made in one instance to a 60,000-volt line by supporting the insulators on railroad ties piled high enough to keep the wires off the ground. Current was thus maintained through the storm with the exception of a few hours.

Business Items

The Wagoner Electric Co., of St. Louis, has removed its Buffalo office to 16 Carlton St. Alfred W. Baldwin will take charge as branch manager.

The William B. Pierce Co., of Buffalo, N. Y., manufacturers of the Dean Boiler Tube Cleaner, has removed its New York office to 480 Lexington Ave.

The Air Compressor & Equipment Co., of Portland, Ore., has been incorporated by George Larrabee, Guy A. Malcolm and Warren E. Thomas. Capital stock, $21,000.

The Dodge Manufacturing Co., Mishawaka, Ind., has opened a school to teach the minor executives of the firm more efficient methods of modern production and to enable them to handle labor more effectively.

The Mono Corporation of America, 48 Coal and Iron Exchange, Buffalo, N. Y., announce that they have purchased the entire stock of Mono apparatus and accessories from the F. D. Harger Co., Buffalo, N. Y. This includes all rights for the manufacture and sale of their various types of Mono apparatus for the automatic analysis of CO_2, CO, O_2, H_2, SO_2, N_2, Cl, etc.

The Plant Engineering & Equipment Co. Inc., New York City, manufacturers of the well known Corliss Valve Steam Trap, Mason Condensation Meter and other power and heating specialties announces the opening of its twenty-sixth office to care for the increasing demands for its products. M. W. Ehrlich, will be the New Jersey Manager in charge with headquarters at Newark, N. J. and a sub-office at Lyndhurst, N. J.

The Frazier-Ellms-Sheal Co.—J. W. Frazier, J. W. Ellms and R. F. Sheal announce the incorporation of the Frazier-Ellms-Sheal Co. for the purpose of conducting a general engineering business in the design and construction of waterworks, pumping and power plants, water purification and sewage-disposal plants, sewer and drainage systems, and buildings. The offices of the company are in the Illuminating Building, Cleveland, Ohio.

THE COAL MARKET

BOSTON—Current prices per gross ton f.o.b. New York loading ports:

Anthracite	Company Coal
Egg	$8.20@$8.65
Stove	8.45@ 9.05
Chestnut	8.55@ 9.05
Pea	7.05@ 7.40
Buckwheat	3.60@ 3.80
Rice	2.30@ 2.50
Barley	1.25

Bituminous	Clearfields	Cambrias and Somersets
F.o.b. mines, net tons	$2.85@$3.35	$3.15@$3.60
F.o.b. Philadelphia, gross tons	5.05@ 5.60	5.35@ 5.90
F.o.b. New York, gross tons	5.40@ 5.95	5.75@ 6.25
Alongside Boston (water coal), gross tons	7.00@ 7.75	7.60@ 8.00

Pocahontas and New River are practically off the market for coastwise shipment, but are quoted at $6.25@$7.00.

NEW YORK—Current quotations, White Ash, per gross tons, f.o.b. Tidewater, at the lower ports are as follows:

Anthracite	Company Coal
Broken	$7.80@$8.25
Egg	8.20@ 8.65
Stove	8.45@ 9.05
Chestnut	8.55@ 9.05
Pea	7.05@ 7.40
Buckwheat	5.15
Rice	4.50
Barley	4.85
Boiler	4.85

Bituminous Government prices at mines:	Spot
South Fork (best)	$3.25@$3.50
Cambria (best)	3.00@ 3.25
Cambria (ordinary)	2.60@ 2.90
Clearfield (best)	3.00@ 3.25
Clearfield (ordinary)	2.60@ 2.90
Reynoldsville	2.85@ 2.90
Quemahoning	3.25@ 3.50
Somerset (medium)	3.00@ 3.25
Somerset (poor)	2.50@ 2.75
Western Maryland	2.50@ 2.75
Fairmont	2.25@ 2.50
Latrobe	2.60@ 2.90
Greensburg	2.75@ 3.00
Westmoreland ¾ in.	3.40@ 3.50
Westmoreland run-of-mine	2.75@ 3.00

PHILADELPHIA—Bituminous coal prices vary according to district from which they are mined. For ordinary slack the price is $2.45@$2.55; lump, $3.35, at the mines.

BUFFALO—

Anthracite	On Cars, Gross Ton	At Curb, Net Ton
Grate	$8.55	$10.80
Egg	8.80	10.65
Stove	9.00	10.85
Chestnut	9.10	10.85
Pea	7.75	9.30
Buckwheat	5.70	7.75

Bituminous	
Allegheny Valley	$4.80
Pittsburgh	4.65
No. 8 Lump	4.65
Mine-run	4.80
Slack	4.10
Smokeless	4.60
Pennsylvania Smithing	5.70

CLEVELAND—Prices of coal per net ton delivered in Cleveland are:

Anthracite	
Egg	$12.25@$12.40
Chestnut	12.50@ 12.70
Grate	12.25@ 12.40
Stove	12.40@ 12.60
Pocahontas	
Nine-run	$7.50
Domestic Bituminous	
West Virginia split	$8.50
No. 8 Pittsburgh	$6.60@ 6.90
Massillon lump	8.25@ 8.50
Coshocton lump	7.15
Steam Coal	
No. 6 slack	$5.25@$5.50
No. 8 slack	5.10@ 5.50
Youghiogheny slack	5.25@ 5.50
No. 8 ¾ in.	5.70@ 6.60
No. 6 mine-run	5.25@ 5.50
No. 8 mine-run	5.75

Only coal available is mine-run Pocahontas.

MIDDLE WEST—Chicago quotations, f. o. b. cars at mine:

	Springfield, Carterville, Williamson, Franklin, Saline, Harrisburg	Fulton, Peoria	Grundy, La Salle, Bureau. Will
Lump	$2.55@$2.70	$2.95@$3.10	$3.25@$3.40
Washed	2.75@ 2.90		3.45@ 3.60
Mine-run	2.35@ 2.50	2.75@ 2.90	3.00@ 3.15
Screen'gs	2.05@ 2.20	2.35@ 2.50	2.75@ 2.90

New Construction

PROPOSED WORK

Vt., Brattleboro—The Connecticut River Power Co. of New Hampshire, 35 Harvard St., Worcester, Mass., plans to extend the hydro-station at Hinsdale, N. H. and install 4 additional units. Charles A. Harris, Pres.

Vt., Johnson — The Municipal Electric Light Plant plans to install a new generator and switch board.

Mass., Boston—The Reynolds Bldg. Trust Co. is having plans prepared for the construction of an 8 story, 47 x 70 ft. office building on Winter St. A steam heating system will be installed in same. Total estimated cost, $500,000. Parker, Thomas & Rice, 110 State St., Archts.

Mass., North Adams—The H. W. Clark Biscuit Co., 185 Ashland St., will soon award the contract for the construction of a 4 story, 90 x 140 ft. addition to its present plant on Ashland St. A steam heating system will be installed in same. Total estimated cost, $150,000. W. Higginson, 13 Park Row, New York City, Engr.

Mass., Springfield—P. H. Faber, c/o The Oaks, 31 Thomson St., will receive bids about April 1 for the construction of a 4 story hotel addition on State and Thomson Sts. A steam heating system will be installed in same. Total estimated cost, $200,000. Associated Architectural Co., 145 State St., Archt.

Mass., Williamstown—Cram & Ferguson, Archts., 20 Beacon St., Boston, will soon award the contract for the construction of a 3 story, 120 x 120 ft. library building, etc. on the campus, for the William College. A steam heating system will be installed in same. Total estimated cost, $500,000. W. E. Hoyt, Treas.

R. I., Pawtucket—The Blackstone Valley Gas & Electric Co. plans to install oil-burners for the generating system. A. C. Brooks, Mgr.

R. I., Warren—The Mt. Hope Spinning Mill will soon award the contract for the construction of a 2 story, 110 x 200 ft. mill addition on Cutler St. A steam heating system will be installed in same. Total estimated cost, $100,000. Jenks & Ballon, 1035 Grovenor Bldg., Providence, Engrs.

Conn., Middletown — The Trustees of Wesleyan University, 374 High St., are having plans prepared for the construction of a 2 story chemical laboratory building. A steam heating system will be installed in same. Total estimated cost, $500,000. Henry Bacon, 101 Park Ave., New York City, Archt. and Engr.

Conn., New Britain — The New Britain Children's Home, 81 Garden St., is having plans prepared for the construction of a 3 story, 96 x 266 ft. school and home on Rackliffe Heights. A steam heating system will be installed in same. Total estimated cost. $350,000. Walter P. Crabtree, 272 Main St., Archt. and Engr.

Conn., New Britain — The World War Veterans, c/o Clarence C. Palmer, Archt. and Engr., 272 Main St. plan to construct a 4 story, 60 x 150 ft. club house on North and Beaver Sts. A steam heating system will be installed in same. Total estimated cost, $200,000.

Conn., New London—The Soltz Co., 52 John St., plans to construct a 1 story cold storage building on Main St.

N. Y., Albany—York & Sawyer, Archts. and Engrs., 50 East 41st St., New York City, will soon award the contract for altering the present bank building, for the Commercial Trust Co., c/o Archts. A steam heating system will be installed in same. Total estimated cost, $100,000.

N. Y., New York—The Flatbush Gas Co., 1034-36 Flatbush Ave., Brooklyn, plans to construct 72—13,200 volt power feeders. H. E. McGowan, Secy.

N. Y., New York—John H. Sheier, Archt. and Engr., 25 West 42nd St., will soon award the contract for altering loft, showroom and store building on 6th Ave. between 20th and 21st Sts., for the United States Realty Improvement Co. A steam heating system will be installed in same. Total estimated cost, $300,000.

N. Y., New York—The Sheridan Realty Co., c/o Reilly & Hall, Archts. and Engrs., 749 5th Ave., is having plans prepared for the construction of a 152 x 202 ft. theatre on Sheridan Sq. A steam heating system will be installed in same. Total estimated cost, $500,000.

N. Y., New York—The Silk Traders, Inc., c/o G. and E. Blum, Archt., 505 5th Ave.,

is naving plans prepared for the construction of a 12 story loft building on 4th Ave. A steam heating system will be installed in same. Total estimated cost, $600,000.

N. Y., New York—The Society of Professional Automobile Engrs., B'way and 67th St., is having plans prepared for the construction of a 5 story, 55 x 100 ft. club building at 153 West 64th St. A steam heating system will be installed in same. Walter Haefel, 229 West 42d St., Archt. and Engr.

N. Y., New York—The United States Electric Light & Power Co., 130 East 15th St., plans to install one 22,000 kw. turbo generator unit, construct a 300,000 kw. generating station and change the transmission voltage from 7,500 volt to 15,000 volt. Frank W. Smith, Mgr.

N. Y., Queensborough — The Queensborough Gas & Electric Co., 1530 Far Rockaway Blvd., Far Rockaway, plans to construct an addition to generating station and install 2 additional 600 hp. Babcock Wilcox boilers. Carleton Macy Mgr.

N. J., Montclair — The Montclair Golf Club, c/o H. P. Knowles, Archt. and Engr., 52 Vanderbilt Ave., New York City, is having plans prepared for the construction of a 3 story, 50 x 220 ft. club building. A steam heating system will be installed in same. Total estimated cost, $200,000.

N. J., South River—The Bd. of Pub. Wks., Borough Hall, will receive bids until April 12 for the construction of a 59 x 78 ft. addition to the electric generating station and the installation of two 300 hp. boilers, 175 lbs. gauge pressure, 50 degrees superheat, two 500 kw. turbo generators, two 500 kw. condensers, two circulating water pumps, one water heater, etc. E. B. Hedden, Supt. Goss, Bryce & Johnson, 55 Liberty St., New York City, Engrs.

Pa., Philadelphia — Clark & Dudnick, Archts. and Engrs., Drexel Bldg., will soon award the contract for the construction of a 3 story, 42 x 60 ft. store building on 5th and South Sts., for Harry Krengel, 5th and South Sts. A steam heating system will be installed in same. Total estimated cost, $100,000.

Pa., Sharpsburg—The Municipal Electric Light Plant Office plans to install a condenser for one 300 kw. turbine. W. C. Wetzel, Supt.

Pa., Souderton—The Souderton Light & Power Co. plans to construct a new 3 ph. transmission system. J. J. Hutchinson, Mgr.

Pa., Verden—The Verden & Lake Ariel Light, Heat & Power Co. plans to extend transmission lines in the spring. W. M. Kiezer, Pres.

Pa., Waynesboro—The Landes Machine Co. is in the market for a 125-200 hp. boiler.

Pa., Wilkes-Barre—The Sheldon Axle Co., 221 Conyngham Ave., plans to construct a 3 story, 100 x 200 ft. heat treating plant on Beaumont St. A steam heating system and electric power will be installed in same. Total estimated cost, $200,000.

Md., Cumberland—G. F. Salisbury, Archt., Citizens Natl. Bank Bldg., will soon award the contract for the construction of a 4 story, 69 x 84 ft. store building on Baltimore St., for the McMullen Bros. Co., Inc., Baltimore St. A steam heating system will be installed in same. Total estimated cost, $125,000.

Va., Blacksburg—The Virginia Polytechnic Institute Heat & Power Plant plans to install a complete new generating system and remodel the transmission system. W. E. Ellis, Dir.

Va., Bridgewater — The North River Electric Co. plans to install a new and larger generator, in 3 phases, more water power and auxiliary steam power and construct a transmission line from here to Mt. Crawford and several mutual lines to surrounding farms. G. R. Berlin, Mgr.

Va., Chatham—The Chatham Light & Power Co. plans to install a 3 mi. line on the West side for power and light in generator system. Jonas V. Young, Mgr.

Va., Fredericksburg—The Rappahannock Electric Light & Power Co. plans to install 500 kva. steam turbine boilers in generator system and reconstruct distributing system. S. C. Foster, Supt.

Va., Shenandoah—The Municipal Water & Light Plant plans to install a 300 kva generator. A. V. Kern, Supt.

Va., Warrenton—The Warrenton Electric Light & Power Co. plans to install one 90 kw., 2,200 volt, 60 cycle generator and one 150 hp. Erie boiler and construct 5 mi. of additional transmission line. M. J. O'Connel, Mgr.

W. Va., Charleston—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., plans to build an outdoor electric substation and install equipment in same, at Naval Ordnance Plant, here.

W. Va., Charleston—C. H. Higgins, Archt. and Engr., 19 West 44th St., New York City, will soon award the contract for the construction of a 7 story, 100 x 150 ft. office building on Virginia and McFarland Sts., for Abney Barnes & Co., 812-818 Virginia St. A steam heating system will be installed in same.

W. Va., Elkins—The Elkins Power Co. plans to install 1 new unit in the generating system. C. C. Bosworth, Mgr.

W. Va., Huntington — The Consolidated Light, Heat & Power Co. plans to construct an 11,000 volt transsmission line from here to Kenova and an 11,000 volt line here. H. L. Evans, Supt.

W. Va., Logan—The Kentucky & West Virginia Power Co plans to construct a 250 mi. transmission line in various territories and install 21,000 in. turbo alternators. A. J. Darrahm, Mgr.

W. Va., Mt. Hope—The Mt. Hope Electric Power & Water Co. plans to construct 2 lines in the transmission system. George Waldo, Supt.

W. Va., Phillippi—The Municipal Electric Light Plant plans to install an 800 hp. steam turbine in generating system. A. D. Poling, Mgr.

N. C., High Point—The High Point Hotel Co., c/o W. L. Stoddart, Archt. and Engr., 9 East 40th St., New York City, is having plans prepared for the construction of a 9 story hotel. A steam heating system will be installed in same. Total estimated cost, $500,000.

Ga., Atlanta—The Georgia Baptist Hospital, 92 Luckie St., is having plans prepared for the construction of a 4 story, 57 x 150 ft. nurses home on the Boulevard. A steam heating system will be installed in same. Total estimated cost, $150,000. Burge, Stevens & Conklin, Natl. City Bldg., Archts.

Tenn., Carthage—The Smith Co. Electric Co. plans to construct an 11 mi. transmission line from here to Monoville, Riddleton and Dixon Springs. R. S. Seese, Mgr.

Tenn., Dickson—The Municipal Electric Light Plant plans to install a complete new unit in the generating system. Eugene S. Payne, Supt.

Tenn., Humboldt—The Municipal Water & Power Plant plans to install a 500 kw. turbine and construct an 8 mi. transmission line. W. M. Case, Mgr.

Tenn., Kingsport—The Kingsport Utilities Inc. plans to construct a sub-station and a transmission line which will supply all city circuits. L. C. Dashiell, Treas.

Tenn., Monterey—The Monterey Light & Power Co. plans to install a 60 hp. engine and a kva generator and construct short extensions to distributing systems. L. C. Parks, Mgr.

Tenn., Somerville—The Municipal Water & Light Plant plans to install one 25 hp. oil engine connected to a 37½ kw. generator. J. L. Sanders, Supt.

O., Akron—The Seiberling Hotel Co., c/o F. A. Seiberling, is having preliminary plans prepared for the construction of a 20 story hotel and theatre building. Two or three boilers will be installed in same. Total estimated cost, $5,000,000. George B. Post & Sons, 1109 Schofield Bldg., Cleveland, Archts.

O., Bexley—The Bd. Educ. is having plans prepared for the construction of a 2 story, 80 x 125 ft. graded school on Main St. A steam heating system will be installed in same. Total estimated cost, $200,000. O. D. Howard, 8 East Broad St., Columbus, Archt.

O., Cincinnati—The United States Engineer's Office, War Dept., Washington, D. C., rejected all bids for the construction of the power house dam 35, in the Ohio River.

O., Cleveland—The Bd. Educ., East 6th St. and Rockwell Ave., is having plans prepared for the construction of a 1 story school on Parkgate Ave. Two steam heating boilers will be installed in same. Total estimated cost, $500,000. F. G. Hogan, Dir. W. R. McCormack, Archt.

O., Cleveland—The Bd. Educ., East 6th St. and Rockwell Ave., will soon award the contract for the installation of a heating and ventilating system in school. Total estimated cost, $30,000. W. R. McCormack, Engr.

O., Cleveland — The Bd. of Co. Comrs., Court House, plans to construct a 1 story heating plant on Lakeside Ave. and West 3d St. Estimated cost, $200,000. E. G. Krause, Clk.

O., Cleveland — The Brooklyn Catholic Club, 4419 Pearl Rd., plans to construct a 2 story, 70 x 200 ft. club house on Pearl Rd. and Leopold Ave. A steam heating system will be installed in same. Total estimated cost, $100,000. H. Post, Secy. M. Rousseau, 1775 Wickford Rd., Archt.

O., Cleveland—The Cataract Motor Sales Co., 8818 B'way, plans to build a 3 story, 80 x 250 ft. garage and auto sales building at 8807 B'way. A steam heating system will be installed in same. Total estimated cost, $100,000. Address A. J. Schustrich.

O., Cleveland — The Cleveland Discount Co., Rockefeller Bldg., has purchased a site on Superior Ave., near East 9th St. and plans to build a 20 story, 80 x 200 ft. office building on same. A steam heating system will be installed in same. Total estimated cost, $4,000,000. J. Kirby, Pres. Walker & Weeks, 1900 Euclid Ave., Archts.

O., Cleveland—The Cleveland Ry. Co., Leader-News Bldg., plans to construct 1 and 2 story car barns on Bessemer Ave. and East 79th St. A steam heating system will be installed in same. Total estimated cost, $200,000. J. Stanley, Pres. D. W. Morrow, 4500 Euclid Ave., Archt.

O., Cleveland—The Cleveland Trust Co., East 9th St. and Euclid Ave., plans to build a 4 story commercial building at 2717 Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $300,000. A. A. McCaslin, Vice Pres.

O., Cleveland—C. G. Hale, Real Estate, 340 Leader-News Bldg., plans to construct a 5 story commercial building on Superior Ave. near East 12th St. A steam heating system will be installed in same. Total estimated cost, $150,000.

O., Cleveland—The International Ladies Garment Workers Union plans to construct a 5 story office and club room building on Superior Ave. A steam heating system will be installed in same. Total estimated cost, $100,000. M. Pearlstein, 3[illegible]5 Superior Bldg., Chn.

O., Cleveland—S. W. Manheim & Co., 719 Natl. City Bldg., plans to build a 1 story commercial and theatre building on East 125th St. and Superior Ave. A steam heating system will be installed in same. Total estimated cost, $100,000.

O., Cleveland—The Templar Realty Co., c/o Max Marmorstein, 1605 Williamson Bldg. plans to construct an 8 story, 80 x 200 ft. commercial building on East 81st St. and Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $500,000. S. H. Weis, 1032 Schofield Bldg., Archt.

O., East Palestine—The Municipal Electric Wks. plans to install a 300 hp. W. T. boiler. Jacob Ashman, Pres.

O., Lakewood — The Lakewood Theatre Co., c/o E. Mandelbaum, Sloan Bldg., Cleveland, is having plans prepared for the construction of a 2 story theatre at 15015 Detroit Ave. A steam heating system will be installed in same. Total estimated cost, $200,000. Thomas W. Lamb, 1323 Euclid Ave., Cleveland, Archt.

O., Lima—Elmer McClain, Dir. of Pub. Serv. will receive bids until April 1 for furnishing boiler feed pump to be installed in the Waterworks main pump station.

O., Linden—(Columbus P. O.) The Bd. Educ. received lowest bid for installing heating, plumbing and ventilating systems in the proposed 2 story school from the Hoffman, Wolfe Co., North High St. at $58,000.

O., Massillon—The Bd. Educ. plans to build a 2 story, 76 x 80 ft. school on State St. A hot blast heating system will be installed in same. Total estimated cost, $100,000. Albrecht, Wilhelm & Kelly, Union Bldg., Cleveland, Archts.

O., Massillon—The Bd. Educ. plans to build a 76 x 90 ft. school on Cherry St. A hot blast heating system will be installed in same. Total estimated cost, $100,000. Albrecht, Wilhelm & Kelly, Union Bldg., Cleveland, Archts.

O., Massillon—C. P. L. McLain, Grocer, is having plans prepared for the construction of a 2 story, 40 x 130 ft. commercial building. A steam heating system will be installed in same. Total estimated cost, $60,000. Albrecht, Wilhelm & Kelly, Union Bldg., Cleveland, Archts.

O., New Philadelphia—The Weiss McClung Co. plans to build a 1 and 3 story rubber factory. A steam heating system will be installed in same. Total estimated cost, $300,000. W. F. Ferguson Co., 1900 Euclid Ave., Cleveland, Engr.

O., Orrville—The Bd. Educ. is having plans prepared for the construction of a 2 story, 75 x 125 ft. graded school. A steam heating system will be installed in same.

Total estimated cost, $200,000. L. L. Woods, Clk. O. D. Howard, 8 East Broad St., Columbus, Archt.

O., Piqua—Hall & Lethly, Archts., 807 Fairbanks Bldg., Springfield, will receive bids until March 30 for the construction of a 2 story, 100 x 120 ft. school building in the western section of the city, for the Bd. Educ., City Bldg. A hot water and steam heating system will be installed in same. Total estimated cost, $100,000.

O., Sabina—The Municipal Water & Light Plant plans to install Y. transformers to furnish a 230 volt, 3 phase service. J. C. Phelps, Supt.

O., Willoughby—The Thor Tire & Rubber Co., 802 Society for Savings Bldg., is having plans prepared for the construction of a 1 and 2 story factory on Main St. along the New York Central R.R. A steam heating system will be installed in same. Total estimated cost, $100,000. F. L. Gary, Secy. H. H. White, 802 Society for Savings Bldg., Archt. and Engr.

Ind., Washington — The city has been granted permission by the Indiana Pub. Serv. Comn. to issue bonds not in excess of $70,000 for the improvement of the electric light plant. The City Council plans to install a 500 kw. generator and 2 high pressure boilers equipped with coal conveyors and automatic stokers in same.

Mich., Buchanan—I. S. Rice, Secy. of the Bd. Educ., will soon award the contract for the construction of a 2 story school building. A steam heating boiler, etc., will be installed in same. Total estimated cost, $200,000. R. A. LeRoy, 122 Pratt Block, Kalamazoo, Archt.

Mich., Detroit—The Bd. Educ., 50 B'way Ave., will receive bids until April 7 for the construction of a 7 story, 250 x 350 ft. technical school on Second Ave. Motors for power will be installed in same. Total estimated cost, $2,500,000. Malcolmson, Higginbotham & Palmer, 405 Moffat Bldg., Archts.

Mich., Detroit—Brown & Preston, Archts., 406 Empire Bldg., will soon award the contract for the construction of a 3 story, 100 x 120 ft. factory on East Larned and St. Aubin Sts., for the Superior Machine & Eng. Co., 51 East Fort St. A steam heating boiler and motors for power, etc. will be installed in same. Total estimated cost, $100,000.

Mich., Detroit—The Detroit Stoker Co., 1718 Gratiot Ave., Detroit, is in the market for one 25 cu.ft. capacity air compressor and an air receiver.

Mich., Detroit—The Hannan Real Estate Exchange, McGraw Bldg., plans to build a 5 story, 53 x 141 ft. commercial building on Woodward Ave. and Sibley St. Steam heating equipment will be installed in same. Total estimated cost, $200,000.

Mich., Ford City — (Wyandotte P. O.) William Bearendt, Secy. of the Bd. Educ., Dist. 1, will soon award the contract for the construction of a 2 story, 129 x 148 ft. high school on Main St. Steam heating equipment will be installed in same. Total estimated cost, $200,000. J. G. Kastler & Co., 523 Chamber of Commerce, Detroit, Archt.

Mich., Grand Rapids—Pierre Lindhout, Archt., 817 Lake Drive, will soon award the contract for the construction of a 3 story, 50 x 100 ft. factory, for W. H. Spears. Steam heating equipment and motors for power will be installed in same. Total estimated cost, $80,000.

Mich., Hamtramck—(Detroit P. O.) The Dodge Bros., 1678 Joseph Campau Ave., are having plans prepared for the construction of an 8 story, 77 x 266 ft. factory on Conant Ave. Motors for power will be installed in same. Smith Hinchman & Grylls, 710 Washington Arcade, Detroit, Engrs.

Mich., Highland Park (Detroit P. O.)—The Detroit Osteopathic Hospital, c/o Philip H. Gray, plans to construct a 5 story, 75 x 155 ft. hospital on Highland and 3rd Aves. Complete steam heating and ventilating equipment will be installed in same. Total estimated cost, $250,000.

Mich., Huron—The City plans to build a 2 or 3 story hospital building on Kearney and Stone Sts. Steam heating equipment will be installed in same. Total estimated cost, $125,000. Richard Forman, City Hall, Chn.

Mich., Lansing—The Arcade Theatre Co., South Washington Ave., is having plans prepared for the construction of a 2 story, 109 x 165 ft. arcade and theatre building. A steam heating and ventilating system will be installed in same. Total estimated cost, $450,000. W. S. Butterfield, Mgr. John Eberson, 64 East Van B. St., Chicago, Archt.

Mich., Marysville—Smith, Hinchman & Grylls, Archts., and Engrs., 710 Washington Arcade, Detroit, will soon award the contract for the construction of a 1 and 2 story, 380 x 420 ft. foundry on Michigan Ave. and Cuttle Rd., for the General Aluminum & Brass Co., Boulevard and St. Aubin St., Detroit. Steam and hot blast heating equipment and motors for power will be installed in same. Total estimated cost, $500,000.

Mich., Muskegon—The city rejected all bids for furnishing and installing an additional pumping unit and a 10,000,000 gal. reciprocating pumping unit. Hoad & Decker, Ann Arbor, Engrs. Work will be readvertised.

Mich., Pontiac—The Grand Trunk Ry. System, Brush St., Detroit, plans to build a 1 story roundhouse to have a 50 engine capacity, near Johnson St. Electric power will be installed in same. F. P. Sissons, Brush St. Depot, Detroit, Division Engr.

Ill., Chicago—Alfred S. Alschuler, Archt., 28 East Jackson St., will soon award the contract for the construction of a 7 story, 120 x 175 ft. printing plant on 21st St. and Calumet Ave., for the Columbian Colortype Co., 2141 Calumet Ave. A steam heating system will be installed in same. Total estimated cost, $650,000.

Ill., Chicago—Paul Gerhardt, Archt., 64 West Randolph St., will soon award the contract for the construction of a 6 story 150 x 165 ft. clothing factory on Milwaukee Ave. and Caton St., for the Tennerstedt Mfg. Co., 1936 West North Ave. A steam heating system will be installed in same. Total estimated cost, $500,000.

Ill., Highland Park—The city is having plans prepared for the installation of a filtration plant, extensions to distributing system and 5,000,000 gal. additional pumping equipment. Alvord & Burdick, 8 South Dearborn St., Chicago, Engrs.

Wis., Algoma—The City Water & Light Plant plans to purchase the energy from the Wisconsin Pub. Serv. Co., Green Bay and construct a 63 mi., 66,000 volt, 3 ph., 60 cycles transmission line. E. P. M. McCarthy, Supt.

Wis., Amery—The Apple River Milling Co. plans to construct a 39 mi., 22,000 volt transmission line. W. R. Haney, Supt.

Wis, Amherst — The Amherst Electric Service Co. plans to install a 100 kva. generator and a 50 or 75 hp. oil engine. B. E. Dwinnel, Mgr.

Wis., Belleville—The Belleville Electric Co. plans to install a connection with the Southern Ware Co. and construct an extension to rural transmission lines. W. E. Seward, Supt.

Wis., Colby—The Colby Light & Power Co. plans to construct a connection to high line in generating system. George Tesmer, Mgr.

Wis., Greenwood—The Greenwood Municipal Light & Power Plant plans to extend transmission lines to high line and install 150 hp. in new factory. G. W. Rork, Supt.

Wis., Hartford—The Utility Dept. plans to install boilers. H. J. Peters, Supt.

Wis., Kohler—The city will soon award the contract for the construction of a complete sewage pump station, etc. on Main St. and is in the market for equipment for same. Total estimated cost, $25,000. J. Donohue, North 8th St., Sheboygan, Engr.

Wis., Lowell—The Lowell Light & Power Co. plans to install a vertical alternator. W. F. Pease, Secy.

Wis., Manitowoc—The Wisconsin Aluminum Products Co., 16th and Franklin Sts., plans to construct a 4 story, 60 x 250 ft. factory for the manufacture of aluminum products, on 8th St. A steam heating system will be installed in same. Total estimated cost, $250,000. B. Dalwig, Mgr.

Wis., Medford — The Medford Light & Heating Co. plans to install either a new unit in the generating system or a connection with a transmission system. W. Ungrodt, Supt.

Wis., Owen—Clark Co. is having plans prepared for the construction of a 3 story insane asylum. A steam heating, refrigerating and fan system will be installed in same. Total estimate cost, $350,000. W. G. Royer, Chn. of the Comn. Claud & Starck, Badger Bldg., Madison, Archts.

Wis., Sheboygan—The city plans to construct a 3 story, 100 x 150 ft. high school on North 9th and Jefferson Sts. Steam heating equipment including Kewanees or equal tubular boilers, using any fuel, will be installed in same. Total estimated cost, $250,000.

Wis., Sheridan—The Sheridan Co. Elec-Co. plans to electrify the Carney Coal Mines. Judsen Bibb, Mgr.

Wis., Soldiers Grove—The Soldiers Grove Electric Co. plans to change the generating system from d.c. to a.c. Thomas Sime, Mgr.

Ia., Des Moines — The Iowa Telephone Co., Bell System, 7th and High Sts., is having plans prepared for the construction of a 3 story telephone building. A steam heating and fan ventilation system will be installed in same. Total estimated cost, $300,000. George B. Prinz, Omaha Natl. Bank Bldg., Archt.

Ia., Morning Sun—O. F. Boller, Sec'y of the Bd. Educ., is having plans prepared for the construction of a 2 story school building. Plumbing and heating contracts will be sub-let. Total estimated cost, $200,000. W. E. Hulse & Co., 210 Masonic Temple, Des Moines, Archt.

Ia., Packwood—N. E. Oliver, Sec'y of the Bd. Educ., is having plans prepared for the construction of a 2 story, 58 x 99 ft. school building. The contract for installing heating and plumbing systems will be sub-let. Total estimated cost, $125,000. W. H. Hulse & Co., 210 Masonic Temple, Des Moines, Archt.

Minn., Minneapolis—Jacob Resler, 27 4th St., North, will soon award the contract for the construction of a 3 story, 97 x 110 ft. addition to his business building on 1st Ave., N. A steam heating system will be installed in same. Total estimated cost, $160,000. F. Van Antwerp, 416 Palace Bldg., Archt.

Minn., St. Paul—The Riverview Methodist Episcopal Congregation, c/o Rev. Anton Peik, 529 Bidwell St., will soon receive bids for the construction of a 3 story, 90 x 100 ft. church on West George St. A steam heating system will be installed in same. Total estimated cost, $100,000. A. H. Stem, 601 Endicott Bldg., Archt.

Kan., Topeka—The Atchison, Topeka & Santa Fe Ry. Co., 80 East Jackson Blvd., is having plans prepared for the construction of a central heating plant. Estimated cost, $85,000. John Yonkers, Park Ridge, Chicago, Archt.

Neb., Beaver City — The Beaver City Light & Waterworks plans to install a 150 hp. engine and a 1,000 kva. generator. Earl Roberts, Mgr.

Neb., Howell — The Howell Municipal Light Plant plans to change from d.c. to a.c. system. George Lodes, Secy.

S. D., Flandreau—The Dakota Light & Power Co. plans to construct extensions to transmission lines. A. H. Bushman, Supt.

S. D., Highmore—The Municipal Electric Light & Power Plant plans to change generating systems from d.c. to a.c. A. H. Fehr, Supt.

S. D., Madison—The Municipal Electric Light Plant plans to construct a new power house in the spring and new power circuits for motor load alone. E. G. Quarnstrom, Supt.

S. D., Milbank—The Milbank Power Co. plans to install one 400 hp. Rathbun engine and generator. F. A. Barnard, Mgr.

S. D., Rapid City—The School of Mines, Bd. of Regents, South Dakota University, is having plans prepared for the construction of a 3 story engraving building. A steam heating system will be installed in same. Total estimated cost, $100,000. F. H. Ellerbe, Endicott Bldg., St. Paul, Minn., Archt.

S. D., White Lake—The White Lake Light & Power Co. plans to construct extensions lines and additions to a complete gas and kerosene oil filling station. V. J. Peters, Mgr.

S. D., Worthing—The Worthing Electric Light Plant plans to install one 20 hp. engine and one 12 kw. generator. W. F. Berens, Mgr.

N. D., Leeds—The City Council will soon award the contract for the construction of a 50,000 gal. tank, one 23,500 gal. r.c. reservoir, one triplex pump with d.c. motor, one heater house with heater, etc. Total estimated cost, $35,000. J. H. Husely, City Aud. T. R. Atkinson, Bismarck, Engr.

Mo, Fulton—The Municipal Electric Light & Waterworks plans to install a new 250 kw. unit including engine and generator. W. J. McCarroll, Supt.

Mo., Sarcoxie — The Southwest Electric Light & Milling Co., plans to install a 112½ kva. generator, a new transformer, etc. Arthur Adams, Pres.

Tex., Canadian — The Canadian Water, Light & Power Co. plans to install an 85 hp. engine in the generating system and construct extensions to the transmission lines. Edward Hoover, Mgr.

Okla., Altus—The Municipal Water & Light Dept. plans to install an additional 700 kva. generator with high pressure boilers. Charles H. Welch, Supt.

Okla., Poteau—The Leflore Gas & Electric Co. plans to install generator and one 100 hp. boiler. F. E. Baird, Mgr.

N. M., Clayton—The Village of Clayton plans to install one 100 kva generator. J. H. Bender, Supt.

Ariz., Phoenix — The Bd. Educ. voted $500,000 bonds to construct a high school including a manual arts and liberal arts building and gymnasium. A steam heating plant will probably be installed in same.

Ore., Pillamock—The Coast Power Co. plans to install a 1,000 kw. turbine. C. J. Edward, Mgr.

Ore., Prineville — The Bd. of Directors, Ochoco Irrigation Dist., plans to vote an additional $100,000 bonds for the completion of Ochoco dam and for the construction of distribution system structures, including a high line pumping plant, office building, and warehouse. Total estimated cost, $1,350,000.

Cal., Berkeley—The Bd. Educ. will soon receive bids for the construction of a 2 story school building on Prince and King Sts. A steam heating and ventilation system will be installed in same. Total estimated cost, $200,000. W. H. Ratcliff, Jr., First Natl. Bank Bldg., Archt.

Cal., Dinuba—The Trustees of the Dinuba Union High School Dist. are having plans prepared for the construction of a high school. A steam heating system will be installed in same. Total estimated cost, $120,000. E. J. Kump, Rowell Bldg., Fresno, Archt.

Cal., Sacramento—The California Packing Corp., 6th and G Sts., is having plans prepared for the construction of a 2 story packing house and a 1 story boiler house. Total estimated cost, $80,000. Philip Bush, 101 California St., San Francisco, Engr.

Cal., Sacramento—A. Givan, Forum Bldg., plans to construct a pump house, etc. and install one 20 in. and one 10 in. electric driven centrifugal pumps for the diversion of 35 cubic second ft. of water from the Feather River for agricultural purposes. Estimated cost, $65,000.

Cal., San Diego—The Public Wks. Office received bids March 3 for furnishing and installing complete power plant and electric generating equipment, including piping, distribution systems for electric and steam, 2 oil burning boilers, oil pump, feed water heater, 2 engine driven alternators, 1 engine driven and 1 electric driven exciters, transformers, vacuum pump, separating tank, etc, at the Marine Corps Base here, from Thomas Haverty Co., 801 Maple St., Los Angeles, for work complete $189,650, (2) $31,250, (3) $66,800, (4) $91,600, (5) $560, (6) $620, (7) $8,800, (8) deduct $670, (9) deduct $23,700, (10) deduct $5,000. Noted March 3.

Cal., San Francisco—The McDermott Estate, c/o B. G. McDougall, Archt., 381 Bush St., is having plans prepared for the construction of a 2 story office building on Battery and Halleck Sts. A steam heating system will probably be installed in same. Total estimated cost, $125,000.

Cal., San Pedro—F. O. Adler, c/o Victoria Theatre, is having plans prepared for the construction of a 1 and 2 story, 105 x 125 ft. theatre on 6th St. A steam heating and plenum ventilating system will be installed in same. Total estimated cost, between $75,000 and $100,000. Smith & Pennell, 621 Investment Bldg., Los Angeles, Archts.

Cal., Turlock — The Turlock Irrigation Dist. voted $2,570,000 for reservoir sites and the Don Pedro Dam, $1,028,000 for hydro-electric plant and transmission lines and $510,000 for main irrigation canal laterals and drainage ditches; the Modesto Irrigation Dist., voted $1,180,000 for the Don Pedro dam, $181,000 for the hydro-electric plant, $150,000 for enlarging its main canal, $190,000 for extending drainage system and $298,400 for electric power distributing system. Dam will probably be 280 ft. high, 1,000 ft. long, 177 ft. thick at bottom and 16 ft. thick at top in the Tuolumne River, Tuolumne Co., 40-60 mi. east of here, Modesto; hydro-electric plant will develop 16,000 hp. and 12,000 kw.; main canal will be 40-60 mi. long. Work will be done jointly by both districts. P. F. Jones, Modesto, Chief Engr. for the Modesto Irrigation Dist. A. J. Wiley, Idaho Bldg., Boise, Idaho, Consult. Engr.

Cal., Ukiah—The California Grape Products Co. will build a factory to manufacture grape juice, etc. A 250 hp. boiler plant will be installed in same. Total estimated cost, $100,000.

Cal., Willows—The Willows Improvement Co. engaged A. Moore, Archt., Kohl Bldg., San Francisco, to prepare plans for the construction of a 4 story hotel and store building on Butte and Walnut Sts. A steam heating system will probably be installed in same. Total estimated cost, $215,000. Address L. Briggs.

N. F., Carbonear—The United Municipal Electric Co., Ltd., plans to construct an extension to generating system and transmission lines to 7 small towns. C. Cameron, Secy.

N. S., Oxford—The Oxford Electric Light & Power Co. plans to construct a 10 mi. transmission line from here to Coffingwood and a 10 mi. transmission line from here to Puguash. S. D. Downing, Mgr.

N. S., Yarmouth—The Yarmouth Light & Power Co., Ltd. plans to install a 750 kva. hydro unit with electrical equipment. D. R. Stoneman, Secy.

Que., Dechambeault—The Portneuf Hydraulic Co. plans to install 2 units of 1,000 kw. each. Henri Pare, Mgr.

Que., Montreal—The Allan Enterprises, Ltd., 404 St. Catharine St., plans to construct a 2½ story, 90 x 175 ft. theatre on Cathcart and St. Catharine Sts., West. An oil burning system of heating will be installed in same. Total estimated cost, $500,000.

Que., Montreal—The Standard Shirt Mfg. Co., 213 Delormier Ave., is in the market for a 4 x 6 or a 6 x 6 ft. air compressor with a 75 to 100 lb. pressure.

Que., Westbury—The Corp. of Sherbrooke Gas & Electric Dept., Sherbrooke, plans to construct an 11,000 hp. power house, here, and a 2 mi., 50,000 volt transmission line. Charles Desbraillet, Mgr.

Ont., Belleville—The Public School Bd. plans to build a 2 story school building. Horizontal boilers for a direct heating system will be installed in same. Total estimated cost, $100,000. Beaumont Jarvis, 64 Gloucester St., Toronto, Archt.

Ont., Hamilton—J. and J. J. Allen, Richmond and Victoria Sts., Toronto, plans to build a 1 and 2 story motion picture theatre on King and William Sts. A vacuum steam heating system will be installed in same. Total estimated cost, $500,000.

Ont., Hawkesbury — The Hawkesbury Electric Light & Power Co., Ltd., plans to install one unit, 2,500 hp. water wheel and a 2,000 volt generator James Ross, Mgr.

Ont., Kitchener—The Kitchener Waterloo Collegiate Bd., Frederick St., is having plans prepared for the construction of a 3 story collegiate institute. A vacuum steam heating system with ventilation system will be installed in same. Total estimated cost, $500,000. S. B. Coon & Son, 810 Excelsior Life Bldg., Toronto, Archts.

Ont., Orillia—The Orillia Water, Light & Power Comn. plans to rebuild two 22,000 volt transmission lines. R. H. Starr, Engr.

Ont., Sudbury — The Imperial Oil Co., Ltd., Imperial Oil Bldg., Toronto, plans to build a 2 or 3 story warehouse and distributing station. A steam heating system will be installed in same. Total estimated cost, $200,000.

Ont., Toronto—Mayor Church, City Hall, will receive bids until April 20 for the construction of a 40,000,000 imperial gal. low lift, electrically driven, centrifugal, sewage pump. Estimated cost, $20,000. R. C. Harris, City Hall, Engr.

Ont., Walkerville—The Walkerville Hydro-Electric Comn. plans to install an additional 2,000 kva. power feeder and a 7,500 kva. lighting feeder. M. McHenry, Mgr.

Ont., Woodstock—The Woodstock Light & Water System plans to construct a 13,000 volt sub-station and a 1½ mi., 13,000 volt transmission line. J. G. Archibald, Mgr.

Man., Shoal Lake—The Shoal Lake Municipal Electric Plant plans to install a duplicate unit in the generating system. A. R. Ibbotson, Engr.

Alta., Macleod—The Municipal Electric Light Plant plans to rebuild entire transmission system. Vernon Pearson, Supt.

Alta., Red Deer—The West General Electric Co., Ltd., plans to install new boilers and one new generating unit. W. A. Moore, Mgr.

B. C., Ladysmith—The Municipal Electric Plant plans to install a 50 kw. generator and a 2,200 volt, 60 cycle, 3 phase Diesel engine. M. A. Morrison, City Clk.

Sask, Arcola—The Arcola Light & Power Co. plans to install a 30 hp. 2,200 volt motor for driving local brickyard for day power service. H. Forbes, Roberts, Mgr.

Sask., Moose Jaw—The Municipal Light & Power Dept. plans to install water tube boilers. J. D. Peters, Mgr.

CONTRACTS AWARDED

Vt., Lunenburg—The Fitzdale Paper Co. will build a 1 story power house. Estimated cost, $1,000,000. Work will be done by day labor.

Mass., Boston—Loew's Theatres Inc., 1493 B'way, New York City, has awarded the contract for the construction of a 3 story, 180 x 200 ft. theatre on Massachusetts Ave., to the Fleischman Co., 531 7th Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $150,000.

Mass., Brookline—The Co-Partner Association, Old South Bldg., Boston, has awarded the contract for the construction of a 4 and 8 story, 200 x 400 ft. hotel on Beacon St., to Fred T. Ley, Devonshire St., Boston. A steam heating system will be installed in same. Total estimated cost, $1,200,000. John J. Smith, Old South Bldg., Boston, Archt.

Mass., Chicopee—The Dwight Mfg. Co., Front St., has awarded the contract for the construction of a 5 story, 72 x 314 ft. manufacturing plant addition to the Casper Ranger Constr. Co., 20 Bond St., Holyoke. A steam heating system will be installed in same. Total estimated cost, $500,000.

Mass., East Boston—(Boston P. O.) A. D. Stefano, Everett St., will build a 2 story ice plant on Everett St. Estimated cost, $30,000. Work will be done by day labor.

Mass., Worcester — The Simplex Player Action Co., 10 Blackstone St., has awarded the contract for the construction of a 5 story, 80 x 150 ft. manufacturing plant on Summer and Charles Sts., to Will Daniels & Sons. A steam heating system will be installed in same. Total estimated cost, $150,000.

Conn., Bridgeport—The United Illuminating Co., 84 Temple St., New Haven, has awarded the contract for the construction of a power plant on East Main St., to C. W. Blakeslee & Sons, 58 Waverly St., New Haven. Noted March 9.

Conn., Greenwich — The Indian Harbor Yacht Club, Putnam Ave., has awarded the contract for the construction of a club house, to C. T. Wills, Inc., 286 5th Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $160,000.

Conn., Stamford—The Carlisle Tire Corp., 251 4th Ave., New York City, has awarded the contract for the construction of a 1 story factory on Fairfield Ave., to the Wells Constr. Co., 237 5th Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $250,000.

Conn., Torrington—The School Comn. has awarded the contract for the construction of a 2 story school addition on Pythian Ave., to the Torrington Bldg. Co., 197 Water St. A steam heating system will be installed in same. Total estimated cost, $90,000.

N. Y., Bath—The Directors of the Soldiers and Sailors Home have awarded the contract for repairing and altering the heating construction at the New York State Soldiers and Sailors Home, to W. B. Armstrong Co., 3 Fulton St., Albany, at $7,700.

N. Y., Brooklyn—Louis Gold, 44 Court St., will build a 6 story, 50 x 140 ft. factory on Pearl and Tillery Sts. A steam heating system will be installed in same. Total estimated cost, $300,000. Work will be done by day labor.

N. Y., Brooklyn—The Israel Hospital Inc., 1246 42nd St., New York City, will build a 3 story, 115 x 180 ft. hospital at 4801 10th Ave. A steam heating system will be installed in same. Total estimated cost, $410,000. Work will be done by day labor.

N. Y., Coney Island (Brooklyn P. O.)—G. Gordon, c/o McCarthy & Kelly, Archts. and Engrs., 16 Court St., Brooklyn, will build a 1 story, 30 x 114 ft. theatre on 31st St. and Surf Ave. A steam heating system will be installed in same. Total estimated cost, $125,000. Work will be done by day labor.

N. Y., Jamaica—The Bd. Educ., 500 Park Ave., New York City, has awarded the contract for the construction of a school building to be known as Public School 50, on 101st St. and Liberty Ave., to J. McArthur, 22 Ormond Place, Brooklyn. A steam heating system will be installed in same. Total estimated cost, $530,000.

N. Y., Long Island City—The Interstate Land Holding Co., c/o J. J. Gloster, Archt. and Engr., 44 Court St., has awarded the contract for the construction of a 3 story,

100 x 100 ft. factory on 14th St. and Governor Pl., to Louis Gold, 44 Court St. A steam heating system will be installed in same. Total estimated cost, $150,000.

N. Y., New York—The Bd. Trustees, Bellevue State Hospital, office of General Medical Supt., 415 East 26th St., has awarded the contract for the installation of boiler, pumps, etc., in the new boiler plant at Fordham Hospital, to the Chute, Thornton & Bailey Corp., 2 East 13th St., at $36,500.

N. Y., New York—M. F. Holmes, c/o C. E. Birge, Archt. and Engr., has awarded the contract for the construction of an 8 story, 35 x 100 ft. store and loft building at 43 West 57th St., to R. H. MacDonald, 29 West 34th St. A steam heating system will be installed in same. Total estimated cost, $115,000.

N. Y., New York—Powers, Weight & Rosengarten Co., 145 Front St., has awarded the contract for the construction of a 50 x 60 ft. office building at 27-31 Depeyster St., to W. S. Patten, 52 Vanderbilt Ave. A steam heating system will be installed in same. Total estimated cost, $100,000.

N. Y., New York—The Sloane Estates Inc. has awarded the contract for the construction of a 2 story, 84 x 90 ft. loft building at 234-242 West 39th St., to Fred. T. Ley, 19 West 44th St. A steam heating system will be installed in same. Total estimated cost, $300,000.

N. J., Jersey City—The Whitlock Cordage Co., Communipaw Ave., has awarded the contract for the construction of a 4 story building on Communipaw Ave., to the John W. Ferguson Co., United Bank Bldg., Paterson. Four new 400 hp. boilers and one 500 kw. and one 1,000 kw. turbines will be installed in same. Total estimated cost, $500,000.

Pa., Philadelphia—The Model Mills Co., Ontario and 9th Sts., has awarded the contract for the construction of a 4 story, 60 x 160 ft. factory, to William Steele & Sons Co., 16th and Arch Sts. A steam heating system will be installed in same. Total estimated cost, $150,000.

Md., Westport (Baltimore P. O.)—The Consolidated Gas, Electric Light & Power Co., Lexington Bldg., Baltimore, will build a 1 story, 75 x 150 ft. electric power house. Estimated cost, $60,000. Work will be done by day labor.

Va., Roanoke—The Viscose Co., Marcus Hook, has awarded the contract for the construction of a 3 story hotel, to C. J. Phillips. A steam heating system will be installed in same. Total estimated cost, $300,000.

N. C., Hickory—The city has awarded the contract for installing a heating system in the proposed 2 story municipal office building, to F. B. Ingold, at $5,480.

La., New Orleans—The Hibernia Bank Trust Co., Carondelet and Gravier Sts., has awarded the contract for the construction of a 16 story bank and office building on Carondelet St., to George A. Fuller, 175 5th Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $2,000,000.

O., Barberton—The Diamond Match Co. has awarded the contract for the construction of a 4 story, 125 x 175 ft. factory, to the Turner Constr. Co., 244 Madison Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $475,000.

O., Cleveland—The Brown Body Corp., 3147 Superior Ave., has awarded the contract for the construction of a 1 story, 60 x 170 x 260 ft. and a 3 story, 100 x 170 ft. factory buildings on West 90th St. and Maywood Ave., to the H. K. Ferguson Co., 6532 Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $500,000.

O., Cleveland—The Champion Forge & Machine Co., East 71st St. and Union Ave., has awarded the contract for the construction of a 3 story, 60 x 120 ft. factory, to the Charles Peterson Co., 4500 Euclid Ave. Estimated cost, $100,000.

O., Cleveland—The city has awarded the contract for furnishing a combination steam and hot air rotary drver, to the Ohio Machine & Boiler Co., 1501 University Rd., at $12,350.

O., Cleveland — The Cleveland Home Brewing Co., 2501 East 61st St., has awarded the contract for the construction of a 1 story, 30 x 135 ft. ice plant and a 30 x 50 ft. boiler room addition, to the F. W. Ruple Constr. Co., 4500 Euclid Ave. Total estimated cost, $60,000.

O., Cleveland—The Federal Packing Co., c/o W. Bressler, West 65th St., will build a 2 story, 40 x 70 ft. cold storage building on East 4th St. and Bolivar Rd. Total estimated cost, $50,000. Work will be done by day labor.

O., Cleveland—Van Aker & Strock Co., 6532 Euclid Ave., has awarded the contract for the construction of an 8 story, 85 x 185 ft. commercial building at 4300 Euclid Ave., to A. U. Kilbourne Co., 6532 Euclid Ave. Steam heating boilers will be installed in same. Total estimated cost, $500,000.

O., Columbus — The Felber Biscuit Co., Grant and McCoy Aves., has awarded the contract for the construction of a 6 story, 62½ x 100 ft. factory on Grant Ave., to R. H. Evans & Co., Columbus Savings & Trust Bldg. A steam heating system will be installed in same. Total estimated cost, $150,000.

O., Dayton—The Allsteel Ridewell Tire & Rubber Co., Lindsey Bldg., has awarded the contract for the construction of a 3 story factory in the northern part of the city, to the Osborn Eng. Co., 2848 Prospect Ave., Cleveland. Plans include a power plant, etc. Total estimated cost, $100,000.

O., Euclid—The Hopkins School Association has awarded the contract for the construction of a 1 story, 80 x 300 ft. school on Mayfield Rd., to Crowell & Little, Marian Bldg., Cleveland. A steam heating system will be installed in same. Total estimated cost, $200,000.

Ind., Kokomo — The Pittsburgh Plate Glass Co., Vaile Ave., has awarded the contract for the construction of a 12,000 kw. steam power station, to Stone & Webster, 120 B'way, New York City.

Mich., Detroit—The city has awarded the contract for furnishing a low lift sub-structure pumping station, to the Walsh Constr. Co., Davenport, Ia.

Mich., Detroit—The Dept. of Purchases & Supplies, Municipal Courts Bldg., has awarded the contract for furnishing one 2 motor mono-rail hoist with a 2-ton capacity, 25 ft. per min. hoisting speed and height of lift, 30 ft. and a trolley motor with a traveling speed not less than 150 ft. per min., to the Detroit Hoist & Machine Co., Clay Ave., at $1,060.

Mich., Owosso—The city, c/o J. H. Robins has awarded the contract for the construction of a 2 story hospital building on West King St., to C. H. Maliskey & Son, at $127,-264. A steam heating boiler, etc., will be installed in same.

Ill., Pullman—(Chicago P. O.) The Pullman Co., manufacturers of railroad cars, 79 East Adams St., has awarded the contract for the construction of a 1 story, 45 x 160 ft. and a 60 x 170 ft. factory buildings on 104th St. and Erickson Ave., to the E. W. Sproul Co., 2001 West 39th St., Chicago. A steam heating system will be installed in same. Total estimated cost, $175,000.

Wis., Colfax—The Colfax Electric Co. has awarded the contract for the construction of a diversion dam, power house, headrace and installation of equipment, to Siems, Helmers & Schaffner, 514 Guardian Life Bldg., St. Paul, Minn. Total estimated cost, $100,000.

Mo., Kansas City—The Gate City Natl. Bank, c/o Wilson B. Plauck, 10th St. and Grand Ave., has awarded the contract for the construction of a 4 story, 50 x 115 ft. bank and office building at 1109 Grand Ave., to the Fogel Constr. Co., Reliance Bldg. A steam heating system will be installed in same. Total estimated cost, $250,000.

Mo., St. Louis—The United Drug Co., 63 Leon St., Boston, Mass., has awarded the contract for the construction of a 1 story, 45 x 80 ft. boiler house at 3941 Kingshighway, to the West-Lake Constr. Co., Ry. Exch. Bldg. A steam heating system will be installed in same. Total estimated cost, $25,000.

Cal., San Francisco — The Commercial Union Assurance Co., Ltd., and the California Fire Insurance Co., 558 Sacramento St., has awarded the contract for the construction of a 15 story office building on Pine and Montgomery Sts., to the Walker Constr. Co., Monadnock Bldg. Boilers, etc., will be installed in same. Total estimated cost, $1,000,000.

Cal., San Francisco—The Pioneer Motor Co., 307 Golden Gate Ave., has awarded the contract for the construction of a 4 story, 120 x 219 ft. auto sales building on Van Ness Ave. and McAllister St., to the Clinton Constr. Co., 140 Townsend St. Motors, etc., will be installed in same. Total estimated cost, $200,000.

Que., Montreal—The Montreal Tramways Co., Tramway Bldg., has awarded the contract for the construction of a 70 x 90 ft. power sub-station on Cote St., to the Raymond Concrete Pile Co., 10 Cathcart St. Estimated cost, $45,000.

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